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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

ANNUAL INVESTIGATIVE REPORT FOR 1931

and

PROGRAM FOR 1932

COLORADO STATE FOREST SERVICE
FORT COLLINS, COLORADO

NORTHERN REGION
and
NORTHERN ROCKY MOUNTAIN FOREST AND RANGE
EXPERIMENT STATION

MISSOULA, MONTANA

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Investigative Program
Northern Rocky Mountain Region

February 25, 1932.

REGION ONE INVESTIGATIVE COUNCIL

ANNUAL REPORT FOR 1931

and

PROGRAM FOR FISCAL YEAR 1933

COLO... COLLEGE

For the Investigative Council

/s/ Evan W. Kelley
Chairman

/s/ Lyle F. Watts
Secretary

Approved March 8, 1932.

/s/ Evan W. Kelley
Regional Forester

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REGION ONE INVESTIGATIVE COUNCIL

ANNUAL REPORT FOR CALENDAR YEAR 1931
AND
PROGRAM FOR FISCAL YEAR 1933

The annual meeting of the Investigative Council for the Northern Rocky Mountain Region was held at the University of Montana, Missoula, Montana, on January 4 to 6, 1932. All agencies of the Region engaged in forest research were represented. The meeting was larger than usual, due chiefly to a keen interest in the range research work being initiated by the Experiment Station, the usual attendance being increased by a number of individuals interested in this field.

ATTENDANCE

All of the individuals listed below by agencies attended all or part of the council meetings:

U. S. Forest Service, Region One

E. W. Kelley, Regional Forester and Chairman

Elers Koch	Forest Management
Philip Neff	" "
D. S. Olson	" "
Glen A. Smith	Range Management
Thomas Lommasson	" "
K. D. Flock	" "
M. H. Wolff	Lands
R. F. Hammatt	Public Relations
F. J. Jefferson	Operation
W. I. White	"
H. R. Richards	"

Northern Rocky Mountain Forest & Range Experiment Station

L. F. Watts, Director and Secretary	
R. H. Weidman	Silviculture
I. T. Haig	"
H. T. Gisborne	Fire
L. G. Hornby	"
G. M. Jemison	"
M. I. Bradner	Forest Survey
G. M. DeJarnette	" "
I. V. Anderson	Forest Products
C. N. Whitney	" "
L. C. Hurtt	Range Investigations

University of Montana

C. H. Clapp, President		
T. C. Spaulding, Dean		School of Forestry
Dr. C. A. Schenck, Special Lecturer	"	"
J. H. Ramskill, Professor	"	"
F. G. Clark	"	"
I. W. Cook	"	"
C. W. Waters	"	"

University of Idaho

Dr. E. E. Hubert, Acting Dean, School of Forestry

Montana State College

Professor M. L. Wilson, Dept. of Agricultural Economics
J. E. Norton, Superintendent, Judith Basin Field Station

Office of Blister Rust Control

S. N. Wyckoff
C. C. Strong
C. H. Johnson

Bureau of Entomology

J. C. Evenden, Coeur d'Alene Field Station

Weather Bureau

F. C. Crombie, in charge of Fire-Weather Studies

Park Service

Wm. Rush, in charge of Elk Study

Indian Service

C. D. Faunce
C. E. Coe

Private Timber Operators

C. L. Billings, Potlatch Forests Inc., Idaho
Roscoe Haines, A. C. M. Co., Montana

Private Livestock Operators

V. O. McWhorter, Triangle Sheep Co., Washington
W. A. Denecke, The Rambouillet Company, Montana

Other Agencies

Evan W. Hall, Agricultural Agent, C. M. St. P. & P. R. R.

MATTERS OF GENERAL INTEREST

Consolidation and Expansion of Forest Service Research

Prior to July 1, 1931, the activities of the Northern Rocky Mountain Forest and Range Experiment Station were confined to studies in the management of the western white pine type and to certain fundamental phases of the fire control problem. The progress in these two fields was definitely limited by the small amount of funds available for this work. On July 1, 1931, however, in accordance with the Forest Service policy of placing all organized research under one agency, the Office of Forest Products was transferred from the Regional Office to the Experiment Station. This consolidation should work for better coordination as the work in products and silviculture is often in closely allied fields. Taking over the work in forest products added some $14,900 to the Experiment Station budget.

Coincident with this transfer came an increase of $43,500 for expansion of the work in fire research, for the initiation of the forest survey, and for work in range investigations. This increase raised the station allotment from about $21,000 in F. Y. 1931 to $74,500 for the F. Y. 1932. As a result of these increases the station staff has been enlarged from four technical workers and one clerk-stenographer in F. Y. 1931, to fourteen technical workers, including two year-long assignees from the Regional Office, and two clerk-stenographers in F. Y. 1932. This force will be increased by adding two technical workers and one stenographer as soon as transfers from the administrative organization can be arranged.

In fire research the additional funds made possible the staff appointment of former Forest Supervisor Hornby. With his appointment early in the fiscal year, the Station assumed direction of the studies dealing with the proper placement of man-power (including lookouts and smokechasers) and other facilities, such as roads, trails, and telephone lines necessary for adequate fire control. Hornby's years of practical experience in fire control provide him with an excellent background for this work. The importance of the study can be measured in part by the fact that Region One is contributing assistance to the extent of about $10,000 per year to push the project to completion.

Hornby is also working jointly with Gisborne in a closely allied project, the statistical analysis of data from some 12,000 individual fire reports covering a ten-year fire record from thirteen critical fire Forests. The additional funds for fire research made possible the appointment of Junior Forester Jemison to take over much of the routine of established fire studies, thus releasing Gisborne for work on the statistical analysis.

Due to these two appointments early in the fiscal year, the expanded fire research got under way without any material loss of time. Active work on the Forest Survey and in Range Research, however, was slow in getting started due to the impossibility of recruiting trained personnel during the fire season. One man has now been appointed on the Survey in addition to Bradner who will direct the work in this field; the project is now under way in North Idaho and will be pushed forward as rapidly as funds will permit.

The grazing work is also now well under way, although former Supervisor Hurtt, selected to head up this work because of broad experience in both the technical and practical phases of range management, could not be transferred until October, due to the serious fire emergency which existed during the 1931 summer season. The appropriation for range research limits studies in this field to the short grass ranges of the Northern Great Plains and centralizes field work at the U. S. Range Livestock Experiment Station at Miles City, Montana. Initiation of this work is particularly timely. The past three years' crop failure in eastern Montana due to drought has accentuated the need for an early solution of the land-use problem for that type of country. One of the major phases of the problem deals with the part that should be played by range livestock and the proper use of range lands. Our work in range research will be devoted to a solution of these questions, and there is no doubt that such information is greatly desired and needed.

Extent of Research by All Agencies

Total expenditures for the calendar year 1931 by all agencies amounted to $145,080. This is an increase of $16,948 over reported expenditures for the previous year. This increase is due largely to the expansion of the work of the Northern Rocky Mountain Forest and Range Experiment Station at the middle of the calendar year and to the expanded program, particularly in forest products research, at the University of Idaho. Expenditures by the Bureau of Entomology were also considerably increased. The administrative studies by the Forest Service and research by the Office of Blister Rust Control and University of Montana were decreased on account of curtailment of funds. These decreases are, no doubt, temporary and will be wiped out as soon as economic conditions become better.

The present economic situation emphasizes the importance of and increases the need for information which can only be secured through the medium of research. The same condition places a barrier against the financing of the necessary program, thus presenting a difficult problem in determining priorities and providing adequate funds for those projects selected for attack.

NUMBER OF RESEARCH PROJECTS, AND EXPENDITURES, BY LINES OF WORK
Northern Rocky Mountain Region

Calendar Year 1931
(Last half F. Y. 1931 and first half F. Y. 1932)

Line of Work	AGENCY																TOTALS	
	Univ. of Idaho		Blister Rust Cont.		Bur. of Entomology		Weather Bureau		Univ. of Montana		For. Serv.: Region 1		N R M Exp. Sta.					
	No.	Amt.	No.	Amt.	No.	Amt.	No.	Amt.	No.	Amt.	No.	Amt.	No.	Amt.			No.	Amount
Art. Reforestation	3								2		8	800					13	800
Influences																		
Management	2	3,150							2	35	2		5	11,397			11	14,582
Mensuration									2		2		4	1,510			8	1,510
Protection	4	4,960	8	41,671	8	14,700	4	4,600				9,221	8	14,216			32	89,368
Products	3	11,838							6	75		1,345	9	14,055			18	27,313
Grazing									2	200	6	450	1	2,495			9	3,145
Ecology									2				3				5	
Economics	1	950							2				3	7,012			6	7,962
General and Miscellaneous	1	400															1	400
TOTALS	14	21,298	8	41,671	8	14,700	4	4,600	18	310	18	11,816	33	50,685			103	145,080

The White Pine Situation

The ultimate place of western white pine in the forestry program of the northern Idaho region was questioned a number of times during the annual meeting. The situation is briefly as follows: White pine is at present by far the most valuable tree in the region with the possible exception of western red cedar, at present a much less extensively distributed species. White pine produces a high quality lumber which commands a premium in many markets because of certain special uses for which it is deemed especially fit. As a result, it brings much higher stumpage prices than most of the other species with which it is associated and, in addition, its annual growth and final yields are large. Along with these excellent qualities go several serious drawbacks:

(1) It forms an inflammable type, difficult to protect from fire.

(2) It is a natural host of Dendroctonus monticolae and therefore subject to epidemic insect attacks at recurring intervals.

(3) It is now rather fully exposed to the scourge of white pine blister rust through 61 known infection centers in North Idaho.

Under this combination of excessive fire control costs, susceptibility to recurring attacks of Dendroctonus monticolae, and the necessity of Ribes eradication to prevent blister rust losses, it is an open question as to whether the perpetuation of the white pine type by expensive protection and silvicultural measures can be justified.

It is true that this picture is unduly severe with regard to fire. Western white pine grows normally in a region of light summer precipitation and in mixture with several associates which by themselves constitute a difficult fire problem. This fire control problem will only grow more difficult if disease and insects are permitted to work unrestrained in white pine stands, thus greatly increasing the number of dead trees and snags and raising the fire hazard. Whether or not western white pine remains the key tree in the management of the present white pine type, the protection costs will still remain high.

The situation is distinctly different, however, with regard to bark beetles and blister rust. At present there is a wide-spread epidemic of Dendroctonus monticolae not only in the white pine type but in the lodgepole pine forests to the south and east as well. The epidemic has attained such size and intensity that control measures are not economically feasible on several of the white pine Forests and on most of the lodgepole pine area. The only hope for control appears to be through an increase in the natural enemies of the beetle. It is of course possible that the condition will drop back to normal when we again return to a normal precipitation period. But in any event the cost of adequate bark beetle control is enormous and a legitimate protection charge against the growing of western white pine as the key tree over large areas in North Idaho.

This is also true of the blister rust. In spite of strenuous efforts to keep out or retard the encroachment of this pest into western white pine stands, there are now 61 known centers of infection in this region, and it is believed that these centers constitute only a fraction of the number actually in existence. The normal rate of spread from established centers is so rapid that we can hope to gain control of this disease only by complete Ribes eradication on all areas to be managed for white pine. The original plan for control through stream type eradication is now recognized as inadequate. Previous estimates of control costs, therefore, are far too low.

The problem is, therefore, essentially an economic one and though extremely complex from many standpoints, can be logically resolved into the question of whether or not it will pay to grow white pine in the face of these greatly increasing costs. As much of our research is predicated on the desirability of maintaining or increasing the amount of western white pine in its native region, some members of the council felt that this issue should be squarely faced by all interested agencies. The best answer to the problem is probably a compromise somewhere between the abandonment of western white pine as a major commercial species and its complete protection from all enemies throughout its range. Back of our request for increases for silvicultural research is the immediate need for more study of the growth and yield possibilities of the species commonly associated in the western white pine type.

Unemployment Relief

The 1931 unemployment relief appropriation enabled the Experiment Station to effect a decided improvement in the plant at the Priest River Experimental Forest. Excepting the items for fire breaks and fences, practically all of the funds went towards maintenance or betterment of existing improvements. The following tabulation shows the general distribution and extent of the funds used:

Fire breaks - construction - 1½ miles	$404.52
Fences - construction - 2½ miles	887.12
Dwelling and bunkhouse maintenance (4 bldgs.)	1227.47
Office building	35.59
Other buildings - construction	957.54
Water supply and sanitary facilities - maint.	2387.76
	$5900.00

Cooperation in Fire Suppression

The extreme emergency created by the abnormal 1931 fire season made it necessary to practically turn the man-power of the Station over to the Regional Office for fire suppression duty during the peak period. While the necessity for such action is fully recognized it does follow that there was serious interruption of Station work. The amount of time spent on fire suppression can partially be measured by the fact that the Station allotments were reimbursed from the Fire Fighting fund in the amount of $1385.43 to cover this time. Under the plan of reimbursement the Station suffers no financial loss, but does lose seriously through a reduction in the amount of time available for project field work.

Before the opening of next fire season, a memorandum of understanding of the function of the Station in fire suppression will be prepared for joint approval of the Regional Forester and Director.

Character of the Annual Meeting

The character of the annual meeting again came in for considerable criticism and discussion. The broad scope covered by the programs carried by the several agencies and the many distinct projects upon which work is being done makes it impractical to give adequate consideration to each project. Under this condition there is danger of insufficient coordination of effort and of failure to take advantage of every chance for cooperative action. In order to improve this situation and make certain that the annual meeting will function properly in coordinating and planning future effort the meeting next year will be so organized that the first two days will be given over to open sessions, permitting general discussion, while the third day will be devoted to committee or smaller group consideration of individual projects. The open sessions will be occupied by (1) discussion of the outstanding results of the year, (2) consideration of possible shifts in emphasis to best meet changing conditions, (3) formulation of a broad plan of work for the ensuing year. The smaller group meetings on the third day will give careful consideration to (1) experimental technique, (2) comparative urgency of the individual project, (3) possibility for cooperation, (4) prevention of duplication of work by the several agencies.

Dissemination of Results

The research agencies were again criticized at the annual meeting for failure to get usable and much needed information to forest administrators and lumbermen with sufficient promptness and in such form as to show direct application to forest practice. In order to meet this criticism in part the meeting went on record as favoring the revival of the "Applied Forestry Notes" which were discontinued in 1926. The Experiment Station will act as the distributing agency and will, in editing the material, stress the application of results to forest practice in the region.

Selection of Research Areas

Experimental Forests

After extended search over four or five years, six selections of experimental forests have definitely been made. Two of these, the Priest River and Bernice areas, which have been in existence for some years, were recommended and formally dedicated to research by the Forester under date of April 8, 1931. Definite recommendations for the remaining four areas will be forwarded to Washington as soon as the reports can be prepared in the spring of 1932. Two of these areas are located in the western white pine type, at Deception Creek on the Coeur d'Alene Forest and Pine Creek on the Clearwater Forest. The area for the larch-fir type is at Coram Creek on the Flathead Forest and that for the Ponderosa pine type at Little Trapper Creek on the Bitterroot Forest.

Probably not more than two additional areas will be necessary. One will be desirable in the typical Engelmann spruce type and one may be needed in the Ponderosa pine type of southeastern Montana. It is assumed that the Intermountain Station will select an area in the upper Snake River watershed, thus removing the need for one additional area in the lodgepole pine type north of Yellowstone Park.

Experimental Ranges

The need for two or three experimental ranges, at least one of which should be located in the Missouri River Breaks where vegetation, erosion, and streamflow relationships may be effectively investigated, was pointed out in Hurtt's memorandum, designated R-NRM Supervision of November 21, 1931. Economically sound land classification principles for the Northern Great Plains, minimum ranch units, both natural and harvested feeds considered, reseeding and other phases of the strictly pastoral production problem viewpoint, in addition to the general erosion and streamflow problem might all be combined in the two or three experimental ranges suggested above. The U. S. Range Livestock Experiment Station does not afford all the features desired in each of these several fields of research. Provision should probably be made to include suitable natural areas within the limits of these experimental ranges in the Great Plains region where the necessary supervision may be provided.

Attention is directed to the need for a statement of principles and a comprehensive outline for both experimental ranges and natural areas that will give some coordination of policy between the various regions. The statement and outline drawn up for forest areas scarcely meets the needs in the case of range areas. Pending legislation and growing sentiment for action on the public domain question point to the need for action to select and establish these special areas in the Great Plains section without undue delay. The necessary field work should be done in eastern Montana during the coming field season. Choosing areas inside the National Forests may be delayed until other more pressing range work is under way.

Natural Areas

The selection of natural areas for the preservation of virgin forest conditions was again made incidental to other work. Numerous areas have been considered through correspondence, maps and other information assembled, and field examinations made in several cases. Koch and Weidman, who comprise the committee for selecting and recommending natural areas and experimental forests, plan definitely to make a field examination in 1932 of several areas under consideration. Reports recommending the setting aside of selected areas will be prepared at the end of the field season. No attempt will be made to complete the selection of natural areas during the coming year, and this task will no doubt prove a continuing project for some years to come.

Need for Allotment Increases

The present unhealthy economic condition precludes any possibility of fully meeting research obligations immediately since to do so would require the full amount authorized for the region by the McNary-McSweeney Act, supplemented by an additional appropriation for erosion and streamflow studies. The present situation, however, should not preclude failure to make some progress towards a more adequate attack on the more pressing problems. In many ways the present budget does not permit meeting the most urgent needs of the region in a satisfactory way, with consequent material loss in effort and lack of knowledge on many essentials fundamental to the proper handling of land, forage, and timber resources.

I am listing below important projects, in their order of importance, with the thought that conditions by fiscal year 1934 may justify increases in at least the first two items.

Class of Work	Amount Recommended
Range Research	$30,000
Forest Survey	15,000
Silvical Studies	20,000
Fire Research	15,000
Erosion and Streamflow	15,000
Biological Research	10,000
Forest Economics	5,000

Range Research

The present appalling conditions in eastern Montana testify more clearly than any written work can possibly do to the urgent necessity of making a sound economic classification of these semi-arid range and abandoned homesteaded lands, and deriving the basic principles and methods for their future management and use. These semiarid lands once produced substantial net wealth when used in comparatively large units for range livestock production. Now thousands of acres of abandoned dry farms testify to the unsound type of land utilization attempted in recent years. The evils of this condition are amply illustrated in the census figures for 1930, showing for Montana within the last ten years a decrease of more than 10,000 farms, a loss of nearly three per cent in total population, and some 194 bank failures with deposits exceeding 38 millions of dollars. Most of these misfortunes occurred in the plains section of eastern Montana. There is at last a general agreement that a colossal mistake was made there in land utilization and an earnest desire on every hand to find out what to do about it. The problems involved can only be worked out by cooperative effort by the private, federal, and state agencies. The working out of principles and methods for a sound economic classification and valuation of these semi-arid range and homesteaded lands is essential. Carrying capacity and range utilization experiments with both cattle and sheep are now necessary to determine the economic ranch unit of typical ranges in the short grass region. Practical ways and means of restoring the plant

cover to millions of acres of overgrazed, unproductive lands and to abandoned dry farms must be worked out by experimental methods. Adjustments in range management must be worked out to reduce the excessive transportation rates from this region, through segregation pastures and otherwise. This will insure a higher finished market product direct from the range and, together with certain other adjustments, increase the calf and lamb crops. These are not matters that can be solved by trial and error of the individual. Some of them can best be worked out by cooperation between the Experiment Station, the U. S. Range Livestock Experiment Station, and the Montana Agricultural Experiment Station. To carry its share of this urgently needed work, the range research allotment for the Experiment Station should be increased $12,500.

The range program also needs a substantial increase to work out the fundamentals of proper range utilization on the National Forests. These forest ranges are necessary to the success of many livestock enterprises throughout the region and livestock owners are entitled to scientific and businesslike management of this economic resource. Grazing permits on the National Forests of Region One which covered 202,900 cattle and horses and 988,000 sheep in 1919 were gradually reduced about 26% to 146,000 cattle and horses and 765,000 sheep in 1930. An average of about 3500 permittees is involved. This important and far sweeping reduction was made only after careful study and consideration by competent administrative officials. Nevertheless, it was necessarily based largely on empirical observations and should, in all justice to the officials and livestock owners concerned, be carefully checked by adequate scientific study. Range conditions are by no means stabilized and it is only fair to the livestock owners and the range alike that future changes in carrying capacity should be predicated only upon an adequate scientific basis. To build up the facts upon which scientific management could be based, $17,500 per year is requested for research on National Forest and adjacent ranges.

A total increase of $30,000, therefore, is required in range research to satisfy the urgent needs in this field.

Forest Survey

Previous appropriations have not been sufficient to build up, equip, and keep in the field and office the type and size of organization necessary to initiate and carry on efficiently a project of the scope and value of the Forest Survey. The actual work of estimating, mapping, and check-cruising that has been accomplished to date has been done largely by men assigned from the Regional organization for relatively short periods at odd times during the year. Such procedure does not allow the most efficient use of funds available. Appropriations on the other hand have been so small that the permanent assignment to the Survey organization of a sufficient number of men qualified to do this type of work has been out of the question. If no increase in the appropriation is made, the inventory must continue at a very slow rate and extend a number of years beyond the time limit set up as most desirable. Such a condition is unfortunate, not only because it increases the cost per unit of the area to be covered, but because it lessens the value of some of the information by delaying the date of release.

This condition is particularly undesirable in the Northern Rocky Mountains, primarily a timber producing region. In this area the remaining timber stands are being rapidly cut over, and due to distressing economic conditions, cut-over and burned-over forest lands are becoming tax delinquent at an alarming rate. Lands, tax delinquent for three years or more or foreclosed by the counties, have increased in five northern Idaho counties from two to seven per cent between 1927 and 1930. This is an alarming situation in communities largely or entirely dependent upon logging operations, sawmills, and other wood-using factories for their existence. Such communities are vitally interested in knowing the amount of timber available to their sawmills, the rate at which it is being cut or otherwise depleted, and the requirement for forest products that will keep these wood-using industries active. Such information will prove to be of much greater value if it can be made available to use at the earliest possible date. The lumbermen, forest agencies, and local governments within the region are in agreement that an early completion of the Survey is highly desirable. Increased appropriations will be necessary for the desired early completion of the Survey within this region.

For the above reasons an increase in the Forest Survey appropriation of $15,000 for the F. Y. 1934 is urgently recommended.

Silvicultural Studies

At present the small budget of approximately $15,000 which is available for silvicultural research at this Station restricts the work to the northern portion of the white pine forest type and almost solely to limited phases of methods of cutting and natural reforestation studies on National Forest lands. Nothing can be done with present funds to help solve the cutting and slash disposal problems necessary to make forestry practicable on private timberlands, where conditions are not comparable.

This situation is a very undesirable one. The western white pine is a very valuable tree. About a third of the total lumber cut in the Northern Rocky Mountain region is of this species and indeed the lumber industry in northern Idaho has been built up very largely around western white pine. Sales have been made of National Forest timber at stumpage prices of nearly $12 per M board feet for white pine as compared with $1 to $3 for most of the other species with which it is associated. The region in which it grows is well favored by soil and climate to produce high timber yields and embraces by far the best timber growing portion of the Northern Rocky Mountain territory.

The western white pine type, however, offers forest management problems which are among the most complex in the country. It grows in a mixed forest, in which it may comprise anywhere from 15 to 95 per cent, but ordinarily not more than half of the volume of the stand. The competing species, besides being numerous and of lower value, are often more aggressive in reproducing themselves and capable of thriving in more shade. Difficulties in the western white pine type are

enormously increased by the recent invasion of white pine blister rust. If practical measures of control can not be found the problem will then be how to manage the mixed species. Little is known about the silvical requirements of these species, of, for example, western red cedar, a tree of almost coordinate market value with white pine. A judicious investment in research funds with which to investigate the silvical qualities of the more desirable associates in the white pine type should more than pay for itself in the proper management of this valuable forest resource.

In addition, the western white pine type, though predominately the most important commercial forest type in Region One is by no means the only important one in this section. The larch-fir type comprises the largest forest type in area in the Region and furnishes the greatest part of the lumber cut of Montana. Preliminary studies to indicate proper methods of cutting and regeneration and the yields to be expected are urgently needed for National Forest and private timber operations. Nothing at all can be done in larch-fir forests with present funds.

An increase of $20,000, therefore, is recommended for projects dealing with methods of cutting, slash disposal, and yields in northern Idaho and western Montana Forests.

Erosion and Streamflow

The erosion problem is also a very important one. Erosion in eastern Montana is reducing the depth of fertile top soil at an excessive rate. It has taken ages in this semiarid region to build up a shallow layer of top soil capable of supporting a worth while forage crop. The perpetual maintenance of this enriched soil is essential to the economic use of the region. There are many indications that the rate of erosion has been greatly accelerated during recent years and that this condition is the result of a reduced vegetative cover caused by too heavy grazing. The cycle created is vicious, in that overgrazing depletes the plant cover, thus encouraging erosion which in turn reduces the productivity of the land and capacity of the land for pasture purposes.

This rapid erosion of top soil is also directly part of the flood control problem. The drainages of the Upper Missouri, Tongue, Yellowstone, Musselshell, and other rivers carry immense loads of silt to the Missouri River each year. The silt burden of the Missouri is recognized as a factor in the solution of the Mississippi River flood control problem. Fixing the soil in place is the logical approach to the elimination of the Missouri River silt contribution.

In addition the use, under proper management, of these range lands of the Northern Great Plains is vital to sound and orderly development of many interests. It remains to determine and define through research the type and degree of use that may be had without undue damage to the range through loss of top soil, to the local water-using industries through silting of reservoirs and irrigation canals, and to the nation through excessive silt contributions in the Missouri River. The so-called "breaks" on either side of the

Missouri River present the more spectacular and extreme erosion condition. However, these steep slopes are naturally of very low value for range use, while the more level plains country is capable of producing large amounts of usable forage. It is in this latter type of country that erosion research should be initiated.

To investigate properly the complex relationship of climate, vegetative cover, range use, erosion, and streamflow for this plains region will require not less than $15,000 per year.

Fire Studies

Success in forest fire control depends largely upon ability to anticipate how each fire is going to act under the conditions under which it is or will be burning and on the availability of sufficient man-power and facilities to cope with each situation. The major conditions influencing fire behavior are temperature, atmospheric humidity, wind, topography, and amount and inflammability of fuels. With so many contributing factors the problem of anticipating fire behavior is rendered extremely complex.

The rates of spread for even the most important combinations of fuel, topography, and wind have never been determined, and can be determined only at excessive cost by work on going fires where these factors vary so greatly. The safety of firefighting camps and crews and the tactics of suppression often depend on air currents created by the fire itself as a result of little understood combinations of conditions, yet these air currents and their cause cannot be studied on actual fires because of their large size and the danger involved. In a problem rendered complex by so many natural variables it is often least costly and quickest to take the problem into the laboratory where each factor can be controlled and the results checked by repeated trials with the several factors held constant. This method is applicable to fire problems dealing with rate of spread and similar items, and a wind tunnel in which fires can be created, using particular fuels arranged on simple topographic models with air temperature, humidity, and wind velocity and direction controlled, will permit the determination of fire behavior principles which can be intelligently checked on going fires.

Along with the question of fire behavior and of vital importance to speedy control of fires while they are still small goes the unsolved problem of satisfactory detection service. Statistics of some 12,000 fire records in Region One show that each year 287 fires originate at night, mostly of lightning origin. On the average, fires of night origin cost 50% more than fires of day origin, due largely to their greater elapsed time before discovery. This is a fertile field for study in the attempt to reduce fire control cost and damage. Possible avenues of attack are through improvement in mechanical appliances at lookout points and in the development of photographic equipment to mechanically record the location of each night lightning strike. Another phase of the detection problem which urgently needs careful study is that of effect of atmospheric obscurity on effective detection distance. The work proposed locally would not duplicate similar work

elsewhere but would simply aim to work out the application of the principles to varying atmospheric conditions which exist in this region. The solution of this problem is basic to the correct determination of man-power placement.

A study of the fire research problems listed will require an increase in the annual appropriation for this Station of $15,000. This increase would be largely used during the first two years to bring to completion the more practical studies in man-power placement and visibility now under way. The completion of this phase of the problem will release sufficient money to equip properly a satisfactory laboratory and carry on the more fundamental studies described above.

Biological Research

The true relationship of wild life to forest and range conditions is as yet unknown. Two phases of this work are involved: one dealing with game animals and their place among the forest resources of the region; and one dealing with rodents and lesser fauna which exert an important and often critical influence upon seed supplies and regeneration in the forest and upon grasses and other forage plants on range lands.

No work of this character is provided for by McNary-McSweeney funds in this region at the present time. In order to attack one of the more urgent game problems, however, and purely as a temporary measure which may not continue beyond the present year, the Forest Service and the Game Department of Montana are cooperatively financing a Forest officer in a study of elk problems in Yellowstone National Park and adjacent National Forests. Both the Park Service and the Biological Survey also cooperate in this project.

The Northern Rocky Mountain Region is the largest remaining area of big game in the country. Deer, elk, moose, bighorn sheep, mountain goats, black and grizzly bear are still fairly plentiful. They are an important regional and national asset, not only from the standpoint of recreation and sportsmanship, but from the standpoint of preserving as a national heritage the wild life conditions which have been an intimate part of American frontier history from the days of Daniel Boone to the trail blazers of the West. The elk and in some cases other game animals are now in conflict with livestock in the use of summer and winter ranges and are beginning to lose out in the struggle. The situation is very critical in the case of the elk and is a growing one in the case of deer. In this connection, the Forest Service has been besieged by one of the most influential sportsmen's organizations in the country to close the entire Lewis & Clark Forest to the grazing of livestock. The Regional Forester considers the conflicting use of range by livestock and game animals as a very urgent problem about which something very definitely must be done in the near future. All of the game animals, but particularly the deer and elk, suffer serious losses from coyotes, cougars, and other predatory animals. Adjustment and balance of wild life conditions are urgent and possible of attainment if provision is made for adequately studying the problems involved.

Rodents are a very important factor in reducing the available seed supply and thus contributing, along with such factors as infrequent seed years and dry summers, to the difficulties of establishing reproduction promptly after logging and forest fires. This is an acute problem in Ponderosa pine forests and is also important in white pine timber. Pocket gophers do serious damage to forest plantations. Gophers and ground squirrels are the cause of untold destruction of range resources.

For the above and similar biological studies $10,000 per year is required.

Forest Economics

Funds should be provided for research in the financial aspects of timber growing in western white pine and Ponderosa pine forests. The western white pine forests contain the highly prized white pine and cedar, but along with them a number of other species in mixture which have a very low or negative market value. Many private timber owners might be induced to practice a desirable type of selective logging and careful slash disposal with a view to holding their residual timber for a second cut, if the problem could be adequately investigated with a view to analyzing the economic aspects of logging, manufacture, protection, and taxation along with the silvicultural features. A rapid rate of growth takes place in the white pine forests and much of the private timber land has a relatively high timber producing capacity.

For this study not less than $5,000 should be provided.

PROJECT DISCUSSIONS

Forest Management

Cutting Methods and Reproduction
(M-1, formerly Mc-102, Mr-102, TS-102)

The Experiment Station activity under this heading is devoted chiefly to the remeasurement of permanent sample plots and to a transect study of old cut-over areas. All of the present work is being done in the western white pine type.

The Station now has 29 permanent sample plots which deal with reproduction and methods of cutting. These range in size from one to ten acres and contain over 1300 small quadrats. The plots and quadrats are examined annually for germination, mortality and survival of seedlings, and for seed production of residual trees. At five-year intervals the residual trees are measured for diameter, height, and volume growth.

The principal object of the plots is to determine the methods of cutting best suited for various kinds of stands to secure reproduction and a second crop. In a continuing project like this, the end results are attained only by the gradual building up of facts year by year over a long period. The present plots are planned to run from

fifteen to twenty-five years or more. As they were established mostly in 1926 and 1927, there are now available annual records for the first five years of their existence.

One of the striking findings of the work to date is offered by the phase of the project dealing with parallel screened and unscreened quadrats. These were installed to compare subsequent seeding from seed trees with seed shed before logging or fire. These installations were made following the heavy seed crop of 1926. Except for a few cases of accidental entrance of seed, the screened covers and sides effectively kept seed out of the protected spots after installation. The result in number of seedlings per acre which germinated is shown in the following table covering about four hundred quadrats:

Number of Western White Pine Seedlings Started Per Acre

	Plot 129		Plot 132		Plot 133		Plot 134		Plot 135	
Year	Scr.	Unscr.	Scr.	Unscr.	Scr.	Unscr.	Scr.	Unscr.	Scr.	Unscr.
1927	1000	667	4200	1842	9888	12142	222	833	2200	1400
1928	333	278	634	492	4154	4812	1111	500	200	300
1929	0	56	66	192	0	354	0	56	0	150
1930	0	111	0	108	62	254	0	500	0	50
1931	133	139	0	108	0	146	0	333	0	400

The two facts of vital importance indicated by this series of plots are (1) that on cut or burned-over areas western white pine seed germinates entirely in the first two years after being shed, and (2) that seed trees after cutting may be expected to start a small but dependable amount of reproduction each year, which may amount to about one to thirty per cent (in the case of these plots) of that which starts following a good seed crop shed by the full overwood before logging.

The 1926 seed crop was heavy, and that of 1925 was light. Eighty per cent or more of the germination on Plots 129, 132, and 133 occurred on ground on which the duff was practically burned to mineral soil. It is a very safe conclusion, therefore, that practically all of the reproduction under the screens came from seed shed in the fall of 1926. Seed shed previous to that and stored in the duff played very little or no part whatever in the reproduction secured. A further check on these results is furnished by going experiments in which known quantities of seed have been stored in the duff protected by screening and taken up year by year and germinated in sand flats. In one set of tests the germination results so far are: 42.4% after one year's storage, 27.6% after two years, and 0.8% after three years.

Another outstanding contribution from the permanent sample plots deals with mortality and survival of seedlings of various species in the western white pine type. Average results for 400 quadrats located on five large representative plots are given in the accompanying table. Three of the plots were established in areas burned by

forest fire in 1926, and two in areas logged in 1926. The table shows, for the principal species in the type, the per cent of seedlings germinated in 1927 which died year by year for the succeeding five years.

Per Cent of Seedlings Which Died

Year	Character of Season	White Pine	Larch	Doug. Fir	White Fir	Cedar	Hem-lock	Aver-age
1927	Moist	33	25	19	12	30	41	27
1928	Dry	7	10	3	6	10	18	9
1929	Extr'ly Dry	10	12	9	14	32	19	16
1930	Very Dry	2	2	4	2	6	2	3
1931	Extr'ly Dry	0	1	0	1	3	0	1
Died		52	50	35	35	81	80	56
Survived		48	50	65	65	19	20	44

The important findings are: (1) that a heavy toll is taken of seedlings through drought, high ground surface temperatures, and other causes, amounting to 52 per cent for white pine and ranging from 35 to 81 per cent for the other species; and (2) that over nine-tenths of the mortality occurs in the first three years of the life of the seedlings. The outstanding fact is that seedlings three years old and older can ordinarily be regarded as established and that of seedlings under that age only a certain percentage, frequently less than half, can be expected to survive.

The dependability of the three-year period defining establishment has a particularly strong basis in the present data, in view of the small mortality in the fourth and fifth years despite exceedingly dry seasons in these years.

The transect study of old cut-over areas has now reached the stage of preparation of the report. The field work has been finished and the last of the office computations completed this winter. One of the interesting features of the transect study is the manner in which it has supplemented some of the data gathered on the permanent plots. As has been stated, permanent plot records dealing with reproduction on screened versus unscreened quadrats clearly indicate that seedlings from stored seed and seed shed in the same year as the logging operation will germinate within two years after the removal of the overwood stand. On cut-over areas, therefore, seedlings germinating after this two-year period can be attributed almost entirely to subsequent seeding from live trees left on or adjacent to the area. An analysis of the age of the reproduction present on some 27 typical cut-over areas in the white pine type, examined ten years or more after logging, shows quite conclusively that the great majority of the established seedlings present originated after the third season. Subsequent seeding, therefore, and not stored seed, as heretofore believed by many foresters, has been the main and most important source of seed

in the western white pine type. Indeed, if at least 500 established western white pine seedlings per acre are considered necessary before the cut-over area can be considered desirably stocked, then only 25 per cent of the Forest Service cutting areas examined in this study would have been successful if stored and coincident seeding (seed shed during logging) alone had been depended upon. Both stored and coincident seed play a part in reproducing cut-over areas but subsequent seed has played by far the dominant role.

During 1931 a series of sowing experiments were installed at the Priest River Experimental Forest designed to furnish information on the relative influence of various site factors, such as surface soil temperatures and drought, on early seedling survival in the white pine type. This information is fundamental to the proper silvicultural handling of the mixed stands of the western white pine type in order to encourage adequate reproduction of the more desirable species.

Thinning
(Mt-1, formerly Mt-102)

No field work was undertaken on this project during the past year. The past records of 11 permanent thinning plots, however, were coded for punch card tabulation. Four of these plots are now 15 years old, four are ten years old, and three are five years old. Each plot has been remeasured at five-year intervals and an analysis of these data should furnish interesting information on the effect of thinning on the development, growth, and yield of western white pine stands.

Botanical Studies
(B-1)

Arboretum

An arboretum area of 160 acres was laid out several years ago at the Priest River Branch. The purpose is to plant the area gradually with blocks of approximately an acre each devoted to exotic species of forest trees and species native elsewhere in America to test their adaptability and usefulness in timber growing in northern Idaho. Progress during the field season of 1931 consisted of allocating ground throughout the entire area to genera and species and of planting four blocks to Douglas fir, eastern and western white pine, and Ponderosa pine.

Phenology

This project deals with systematic observations of the time of leafing, flowering, pollination, ripening of seed, wilting, dropping of leaves, etc. The study was in its fourth year in 1931 with observations being taken at 26 stations in the four main forest types of the region. One of the purposes of the work is to correlate the vegetative events of the forest trees and subordinate vegetation with seasonal climate. To accomplish this will require the taking of records over a great number of years.

Racial Varieties of Ponderosa Pine (formerly FS-101d)

This experiment comprises 22 sample plots planted with Ponderosa pine secured from as many localities in the western United States from

the Black Hills to the Pacific Ocean and from the Northern Rocky Mountains to Arizona and New Mexico. The plantations are now 20 years old and are demonstrating some very interesting facts with regard to suitability of different varieties to planting in northern Idaho. On the whole the local stock and that from the northern half of the range of the species show much better height growth and resistance to losses than stock from the south.

Growth and Yield

White Pine (ME-1, formerly ME-102, ME-182, TS-102)

This project is designed to furnish information on the growth and yield of western white pine stands. During the past year half-decade remeasurements were made on twenty-one semipermanent and two permanent yield plots. The Station now has a total of 28 permanent and 56 semipermanent yield plots all located in the western white pine type. Stand values for the semipermanent plots have been computed to date. Data from the permanent plots have been coded for punch card tabulation. An analysis of these tabulations during the coming year should furnish considerable information on the rate of growth in young western white pine stands and permit an interesting comparison with the rates of growth for average fully stocked stands as given in the normal yield tables. The manuscript embodying these normal tables was completed during 1931 and has been submitted for publication.

Larch-fir (ME-2, formerly ME-141 and ME-161)

One Douglas fir plot, established in 1916, was remeasured in 1931. There was no additional field work under this head. All permanent plot records taken in this phase of the work were coded during 1931 for punch card tabulation and analysis.

Fire Attack (Pf-1, formerly Pf, D-1)

Statistical Analysis of Fire Records

During the past year the Experiment Station has initiated a detailed analysis of the histories of some 12,056 fires as recorded by Forest officers in the ten-year period 1921 to 1930. The object of this study is to learn from this great mass of fire experience such facts as will supplement the experience and judgment of fire control officers and indicate the weakness and strength of past organization and practice as an aid in future fire control work. In the past under hand compilation methods, the great complexity of fire conditions, control action, and similar factors made the reasonably complete analysis of fire records an exceedingly formidable task. The advent of the Hollerith machines, however, enabling very rapid sorting and tabulation of data by mechanical means, seemed to place this analysis on an entirely practical basis. Progress during the past year has more than justified this conclusion and it is now felt that in spite of the difficulties involved substantial progress has been made in the statistical study.

The great complexity of the problem, the general type of detailed analysis, and the consequent progress possible with machine tabulation is perhaps best illustrated in a recently undertaken study of discovery time. Discovery time upon first examination appeared to be a very erratic and inconsistent element in fire control work. For example, it was found that during periods of high fire danger, when the detection force had been greatly augmented, that discovery time sometimes increased instead of decreased, as would be ordinarily expected. Again in spite of a steadily increasing number of detection stations throughout the fire forests, detection time averaged about the same in 1930 as it had ten years before. A careful statistical analysis, however, laid bare the reasons for these various inconsistencies. The analysis, in brief was as follows: First it was reasoned that, as the general area covered from one lookout always contains more or less unseen area, fires originating in these unseen spots must burn longer before discovery and thus raise the average discovery time. This is illustrated in the following table based on an analysis of actual fire histories during the 1921-30 period:

For lookout making the first discovery	Discovery Time Hours (1)	Final Area Burned Acres Per Fire	Suppression Cost Per Fire Dollars	Average Discovery Distance Miles	Number of Fires Basis (2)
Seen Areas	5.5	92	331	5.5	2918
Unseen Areas	9.2	207	792	5.5	1417

(1) Average for discoveries within 48 hours.
(2) Only 36% of all fires (12,056) are included here.

Note that during this period fires igniting in unseen areas cost $653,237 more and burned over 162,955 more acres than a similar number of fires originating in seen areas would have done. Here then is a numerical indication of the value of having enough detectors, particularly in periods of high danger, to see all of the area under protection, though of course factors other than detection are involved. In deriving this information it was necessary to handle the entire 12,056 reports, an enormous task in hand compilation, though the condition of seen or unseen was recorded on only 4,335 (36 per cent) of the cases.

Machine sorting and tabulating proceeds so rapidly, however, that the investigator was able to turn without hesitation to analyzing the role of a second factor, the effect on discovery time of fires starting at night and therefore also virtually in unseen area. The data on this point are shown below:

Origin	Ten Year Totals and Averages: Discovery Time (1)	Size of Fire	Cost Per Fire	Number of Fires (2)
	Hours	Acres	Dollars	
Daylight Origin	6.2	64	261	7,922
Darkness Origin	10.8	162	393	2,874

(1) Average time for discoveries within 48 hours - 9302 fires.
(2) Discovery time definitely known for only 10,796 fires.

Fires originating at night during the 1921-30 period cost $379,368 more and burned over 281,652 acres more than a similar number of daylight fires.

Under present detection practices and with available detection equipment those fires which originate at night are seldom discovered prior to the following day (average discovery time of fires of night origin is 10.8 hours). Obviously the addition of more detectors could have little influence in shortening the discovery time of this class of fires, which amount to 36% of the total number. Detection equipment for the location of night lightning fires at the time of strike must be perfected in order to reduce detection time for these fires.

Coincident with an increase of about 50% in the number of manned detection points between 1921-30 has gone a strong drive in fire prevention to reduce the number and per cent of man-caused fires. The change in ratio between percentage of man-caused and lightning fires, shown below, results no doubt in part from this prevention campaign and in part from an increase in numbers of lightning fires.

Period	Proportion of Fires by Causes: % Lightning	% Man-Caused
1921-22	45	55
1923-24	57	43
1925-26	78	22
1927-28	80	20
1929-30	76	24

Unfortunately, from the standpoint of a good detection time record, man-caused fires, being of daylight origin, have a short discovery time while the bulk of the night-starting fires are of lightning origin and have a long discovery time. Thus the fire prevention campaign and in part the increased number of detectors have been directed towards those fires, the most of which originate in the day time. This action is fully justified on the basis of relative costs to suppress man-caused and lightning fires. The following table shows that although discovery time for man-caused fires, mostly of daylight origin, is 2.8 hours as compared to 13.3 hours for lightning fires, man-caused fires cost almost as much per fire to suppress in spite of shorter discovery time.

Cause	Discovery Time 90% of Cases	Average Cost per Fire	Number of Fires
	Hours	Dollars °	
Man-Caused	2.8	322	8110
Lightning	13.3	347	3946

The combined effect of these opposing influences has apparently resulted in an almost stationary average discovery time for all fires over the 1921-30 period as indicated below:

Period	Average Length of Discovery Time Based on Discovery Within 48 Hours
1921-22	6.98 hours
1923-24	6.99
1925-26	8.78
1927-28	6.84
1929-30	7.00

Only by an elaborate and careful consideration of all the principal factors concerned, involving an amount of work prohibitive with hand analysis, has the investigator been able to explain some of the apparent inconsistencies in discovery time over the period concerned.

In summary it should be noted that length of discovery time is also dependent upon a large number of other factors. A reasonably complete list of the factors affecting discovery time would include:

(1) Origin in seen and unseen area.

(2) Origin during darkness as against daylight.

(3) Whether lightning or man-caused.

(4) Visibility conditions.

(5) State of fuels; moist fuels and hence moist years produce more smoke and lower detection time.

(6) Character of fuels with regard to kind and volume of smoke produced on combustion.

(7) Location of fire with regard to type of cover; a stand of green trees conceals smoke longer than a stand of snags and hence lengthens detection time.

(8) Efficiency of detection force. A great deal of further analysis must be made before discovery efficiency can be determined.

° - These costs are not directly comparable to those in previous tables due to inclusion of greater number of fires.

Man-Power Placement and Transportation Facilities

Preliminary results from the statistical analysis have already been used in the new study of man-power placement and transportation facilities in fire control. The data previously cited on discovery time and suppression costs, as influenced by seen and unseen area, indicated the desirability of more complete detection. Since the expense of providing ideal detection with 100 per cent of seen area is prohibitive a compromise was made by determining for different fuel types the maximum size of blind spot which good judgment would permit. The probable size of fire within short times after origin, derived from the statistical analysis, largely governed the size of blind spot permitted. These data were also used in determining the distance (measured in travel time) that one or more smokechasers may be located from a given area and yet satisfy the chosen protection standards. Facts derived in the statistical analysis have also been used throughout in developing standards for detection and smokechaser intensity under different fuel and weather conditions and actually applied in planning the fire control organization for the Clearwater Forest. This plan has demonstrated the impossibility of planning either the detection or first line defense suppression organization by itself, if fire control costs are to be held to the minimum needed to meet the established standards.

It should be stated that very early in the statistical analysis it became evident that effective planning could not be based on average conditions. Instead, the fire control plans in Region One now contemplate an organization prepared to handle the worst 10 per cent of fires, with due allowance for short periods of extreme danger. This decision was based on two findings: (1) Only some 15 per cent of the fires incurred fall into an especially dangerous, fast burning class; (2) Only 0.7 per cent of all Region One fires are responsible for exceeding the area of allowable burn set up by the Washington Regional Foresters' conference. Obviously these are the fires with which we are most concerned in planning an efficient fire control organization. It is probable that the Clearwater plan, with considerable attention given to reasonable protection expenses, will not produce the low burned areas set by the Regional Foresters' conference. A decision must then be made as to whether to intensify the organization or expand the allowable burned area. It may be necessary in sound fire control planning to vary the allowable burned area according to the use for which the forest cover will be grown.

Fire Behavior (Pf-2, formerly B-1, B-5, C-7)

This project, which is now in its tenth year, has three phases. C-7 is the measurement of weather conditions at numerous stations throughout the Region in cooperation with the U. S. Weather Bureau for the improvement of daily fire weather forecasts. B-1 is the recording of observations of lightning storms to obtain better information concerning lightning, the most important cause of forest fires in this Region. B-5 is the more fundamental study of fire behavior, fuel inflammability, and instrumental methods of measuring the current effects of the fuel moisture. These three phases combine to produce

one type of information essential to forest fire control if expenses are to be held down when fire danger is least, and if the damage by fires is to be held within justifiable limits when the danger is great.

The measurement of weather conditions and the daily reports to the Spokane Office of the Weather Bureau were continued. The forecasts issued by the Spokane Office are rated as indispensable by all forest protective agencies of the Region. Administrative action is now taken to reduce fire suppression costs in case of favorable weather forecasts and to reduce damage by increasing suppression forces with unfavorable forecasts. Some further localization of forecasts is still desirable and should be possible with the additional stations planned and with increased experience.

During the past year a summary report was made available to meteorologists and forest protective agencies giving the results of five years of the lightning storm study, covering the period 1924 to 1928 inclusive. This report, "A Five Year Record of Lightning Storms and Forest Fires," was based on a summary of 14,754 observations on storms and contained considerable information that was new to meteorology as well as applicable in fire control. Publication of this report was in the Monthly Weather Review. An abstract from the complete report was issued by Science Service, and part of that in turn copied by the Literary Digest as of interest to the general public.

The third phase of this project has been the most fundamental, the most far reaching, and the most expensive. This work has resulted in the development of the duff hygrometer for measuring duff moisture and inflammability, and the wood cylinder method of measuring the inflammability of slash and branchwood. It has produced a method of rating both current fire danger, from day to day, and seasonal danger so that one fire season can be compared with another. Four new stations were equipped early in 1931 so that current measurements of danger were available for use in fire control from these additional localities during the past season. The three old stations at Priest River were expanded and improved early in the season so that very complete data on fuel inflammability were obtained on a clear cut, a half cut, and a full timbered area. At the close of the season these data were used to supplement weather records in a rating of the 1931 fire season. This rating demonstrated very clearly the exceptionally dangerous character of the past season. Without such a rating it is impossible to determine accurately whether the small area burned was due to high efficiency of the protective organization or whether favorable weather was principally responsible.

This work of measuring the weather elements and their effects on fire danger has now produced a large volume of records permitting the comparison of duff and wood moisture content with any combination of the various weather elements. A first analysis of these data produced a progress report, "Measuring Forest Fire Danger in Northern Idaho," which was published in 1928 as Miscellaneous Publication No. 29. Data for an additional five years have now been accumulated and work has been commenced to analyze all the records.

Even without this detailed analysis of the records, the results of this research project provide information that can be used more than in the past to standardize expansions of the forest protective organization. Two steps were necessary, however, to obtain this increased use. The first was to fit the fuel moisture and weather conditions into their proper places with respect to other factors, such as activity of the fire starting agencies, visibility, etc., which also affect fire danger. All of these factors then needed to be integrated so that the net result of any combination could be expressed in terms of justifiable control action.

The second step was to devise a simple and readily usable means of expressing the result of the integrated factors, rather than by use of several charts, one for each factor. To fulfill this need a small pocket-sized device was constructed, using the idea of one type of photometer or exposure meter employed as an aid in photography. This Fire Danger Meter has now been issued to a selected group for trial and study during the 1932 fire season.

The work to date on this research project has indicated several promising extensions, a few of which are essential if the results so far obtained are to be made of maximum practical use.

In the measurement of weather conditions throughout the Region a few more stations are needed in the centers of large areas of several hundred thousand acres from which no records are now being obtained. The equipment for these stations can be largely supplied by the Weather Bureau while the Forest Service must contribute the operating personnel.

There are three most promising possibilities of making the measurements of fuel moisture more useful. These are: (1) The addition of soil moisture measurements as a further criterion of the dryness of one season, or the accumulated dryness over a period of years; (2) The development of automatically recording instruments so that the operating personnel may leave a station, to chase smokes for example, without loss of the records at the very time when these indices of fire behavior are needed as a check on fire control efficiency; (3) The determination of the effects of wind and slope on the spread of fire.

Provision has been made for a test during 1932 of an instrumental method of measuring soil moisture in place, without introducing the error of sampling and without the labor involved in the conventional method of soil sampling.

The possibility of developing an automatic register for recording all of our fuel and weather measurements also has been broached to the Madison Laboratory. This will be followed actively because of the interference of daily weather measurements with smokechasing or the loss of records when smokechasing removes the personnel from a station.

The third need, of determining the effects of wind and slope on rate of spread of fire, is not only the most urgent but also the most difficult. The need is urgent because wind and slope are universally recognized as very important factors in determining the proper

number of men to send to a fire and in the tactics of suppression so that each fire can be corralled at least cost. This need was also rendered more apparent in the development of the Fire Danger Meter, when the effect of wind had to be integrated with the five other factors. This integration was made in accordance with the results of studies of the behavior of large fires when rate of spread was measured and correlated with wind velocity. These field studies had shown, however, that no two actual fires burned under the same conditions of fuel type, fuel inflammability, topography, wind, and other weather elements. Apparently several thousand fires would have to be studied before data could be collected on enough similar cases to permit drawing conclusions and stating the general principles of fire behavior.

The quickest method of determining these general principles, and the least expensive method in the long run, is to make this study with conditions controllable so that results may be compared and checked. This method of controlled conditions is particularly applicable in a study of complex natural factors. It is being used successfully in all branches of research and has been especially productive in forest research.

The difficulty in making such a study of fire behavior lies in the requirement of a special laboratory that would be rather expensive to install, although operation costs should not be large. This laboratory should consist of a wind tunnel at least 10 or 12 feet in diameter in which the various fuels of forest fires could be burned when they were of definite moisture content, exposed on any desired slope or combination of topography, with the wind velocity provided as desired and the air at the start at any selected temperature and humidity. Likewise the effects of ridges, mountains, and canyons on local wind velocity and direction could be determined so that forecasts of regional winds of specific direction and velocity could be interpreted more accurately according to the particular topography being burned over. Such information is greatly needed by the fire control organization in order to employ the most efficient tactics of suppressing each fire.

Although it may not be possible to obtain the funds next year for such a laboratory, this need should be given high priority in the program for future expansion in this field. The nation-wide significance of the results and the need for expensive laboratory installations may place this project in that class best suited for solution at the Madison Laboratory.

Forest Products

There is presented below a brief resume of a few of the results obtained during the past few years in Forest Products research. The examples illustrate the type of research carried on by this section of Forest Products. This is the sort of information that is essential to the proper management and sale of government-owned timber and that which the private timberland operator must have if he is to analyze his operation and place it on a logging basis which will permit him to leave his cut-over lands in a productive condition at a cost which will leave a profit for his efforts.

Logging and Milling Studies

Selective Logging

The average annual cut of timber in the Northern Rocky Mountain Region during the past ten years has been 1,288,194 M B.M. Of this total 67% has come from privately-owned lands and 69% has been produced by ten companies. The major forest problem of the Region, aside from fire protection, is how to keep cut-over lands productive at a cost within reach of the private timberland operator. The practice of selective cutting is partly predicated on the removal of only those trees which can be handled at a profit and is a long initial step towards the solution of this problem. Regional logging and milling studies have demonstrated the economic desirability of the practice. The following is an example of the type of information made available by such studies.

A revision of the data on the conversion values of Ponderosa pine of different diameters based on 1930 selling values and production costs is interesting. A Ponderosa pine tree twenty inches in diameter could not be converted into lumber with any return for stumpage interest or profit. Likewise, a sixteen-inch tree showed a loss of approximately $5.50 per M and a fourteen-inch tree about $7.60 per M.

The table below compares the conversion value of a Ponderosa pine stand cut to different diameter limits:

Diameter Cutting Limit	Per Cent of Trees Cut	Per Cent Volume Removed	(1) Conversion Value Per M	Per Acre
12" and over	100	100	$0.71	$10.62
20" and over	60	87	1.04	13.00
22" and over	42	78	1.28	12.83

Note: Average stand per acre, 13,000 bd. ft. log scale.

(1) Based on 1930 production costs and selling values.

The graph immediately following this page gives an interesting and useful development of the A. C. M. relogging study in the Ponderosa pine type. This study was located on an area logged about forty years ago by the Big Blackfoot Milling Company. Referring to the graph, it is seen that the diameter growth after release by cutting in 1888 for the average Ponderosa pine tree was 1.03 inches per decade. This is less than the diameter increment of 1.16 inches on the Lick Creek Forest Service sale area on the Bitterroot Forest.

In 1888 the Big Blackfoot Milling Company removed 8040 board feet log scale (Scribner Dec. C) per acre from the area. Ponderosa pine was the principal species cut. They left a residual stand of 2240 board feet per acre in all species 8 inches d.b.h. and larger. In 1927 the A. C. M. Company relogged the area and obtained 4050 board feet per acre in trees 11 inches d.b.h. and over. Thus, one acre produced 1810 board feet b.m. log scale of sawlog and stull material during the 39-year period or at the rate of 47 board feet of log scale

per year. There is at present an excellent residual stand of young timber containing a volume of 1150 board feet log scale per acre in trees eight inches d.b.h. and over. This plus the volume cut (1810 board feet) gives a total growth per acre of 2960 board feet log scale (76 board feet per year) during the 39-year period.

Logging Output Studies

A most comprehensive research in log production has been completed. It furnishes accurate information on costs of logging timber of different sizes and under different conditions. The study shows, for example, that under identical conditions it costs 117% and 43% more, respectively, to log timber averaging 50 bd. ft. per log and 100 bd. ft. per log, than it does timber averaging 200 bd. ft. per log. Similar research has shown that on one operation in northern Idaho there was a loss of 9½% in value in white pine logs transported from woods to mill by river driving as against transportation of the same sized and quality logs by rail.

Waste Investigations

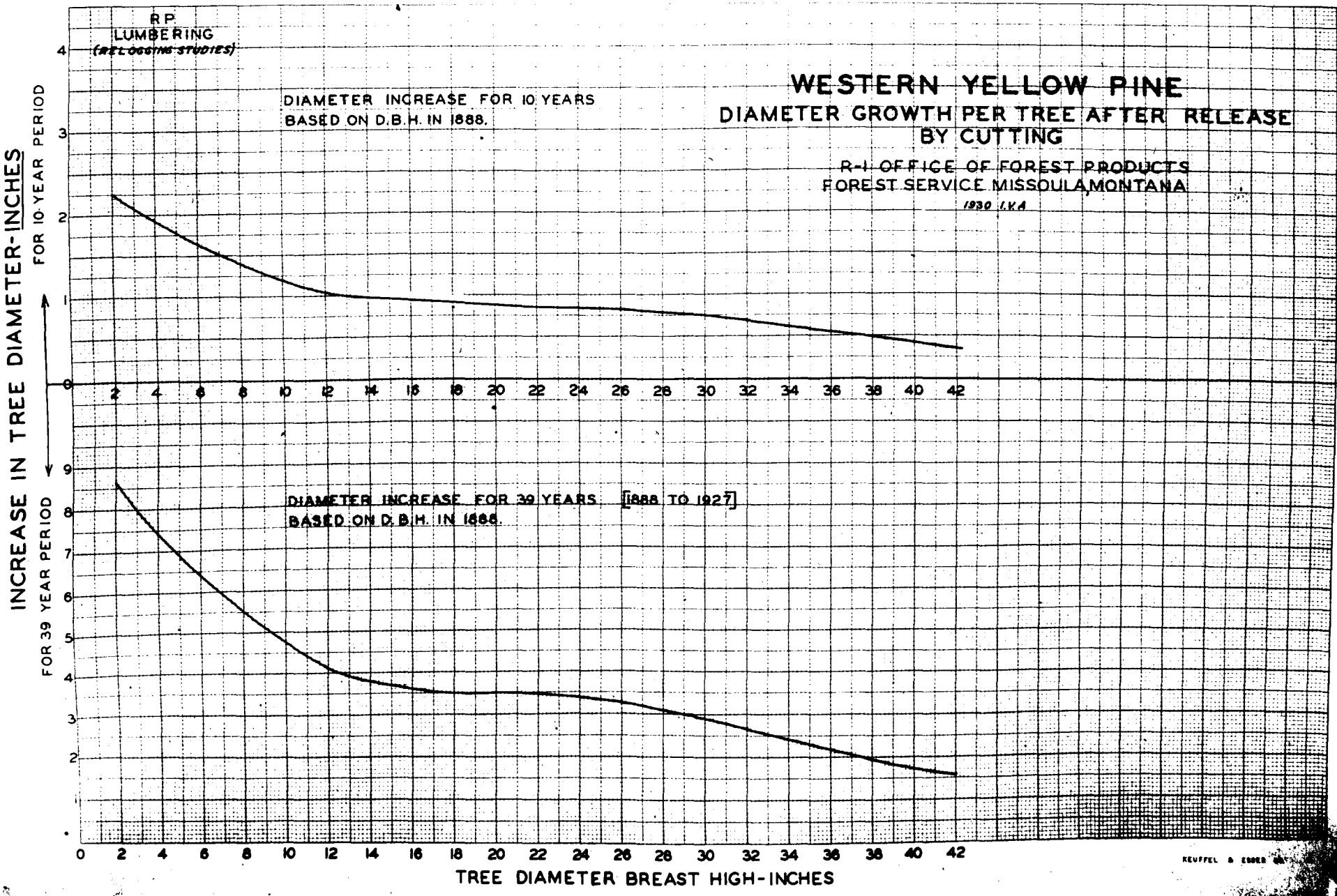
The principal objective of these studies is to aid the lumber industry and the Forest Service in determining more effective methods and practices for reducing wood waste. In order to determine the amount of the wood losses and to find out why and where they occur, wood waste inventories are necessary. Once such data are available efficiency studies of the different types of equipment and methods of manufacture can be made in an attempt to reduce the economic waste in lumber and timber products manufacture. Wood waste inventories have been made in the woods and in the mill and a number of efficiency studies have been undertaken. There is given below some of the results obtained in the recent wood waste investigation studies.

Wood Waste Inventory: This study has been completed for all commercial types of the Region and the final report is now available. Since identical study methods were used in making the survey of all types, a comparison of residual wood after logging in the various types is interesting. All wood losses in the four forest types studies compare as follows:

Western white pine type,	1,322	cu.	ft.	(14.5	cords)	per	A.
Ponderosa pine type,	436	"	"	(4.8	")	"	"
Larch-Douglas fir type,	935	"	"	(10.4	")	"	"
Lodgepole pine type,	829	"	"	(9.2	")	"	"

Results of this survey in the white pine type will not be mentioned since they were presented in last year's report.

Residual wood after logging is the least in the Ponderosa pine type of any of the commercial types of the Region. There follows a tabular summary for this type:


R P
LUMBERING
(RELOGGING STUDIES)
WESTERN YELLOW PINE
DIAMETER GROWTH PER TREE AFTER RELEASE
BY CUTTING
R-1 OFFICE OF FOREST PRODUCTS
FOREST SERVICE MISSOULA, MONTANA
1930 I.K.A
DIAMETER INCREASE FOR 10 YEARS
BASED ON D.B.H. IN 1888.
DIAMETER INCREASE FOR 39 YEARS [1888 TO 1927]
BASED ON D.B.H. IN 1888.
INCREASE IN TREE DIAMETER-INCHES
FOR 10 YEAR PERIOD
FOR 39 YEAR PERIOD
TREE DIAMETER BREAST HIGH-INCHES
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
1 2 3 4
1 2 3 4 5 6 7 8 9

Wood Material Per Acre Left After Logging
Western Montana

Species	Feet Board Measure						Waste	
			Residual Wood Net					
				Stumps			Total board measure basis	Total cubic foot basis
	Volume Logged Per A. Gross	Volume Left Per A. Gross	Merch. Saw-logs	Av. Height Inches	% Defective	Merch. Waste High		
Ponderosa Pine	9520	1110	170	12.9	17	130	1760	294
All Species	10540	1993	200	-	-	140	2260	377

Some of the results of the woods waste inventory have been combined with utilization data secured in the 1925 mill scale study. Charts have been prepared for western white pine, Ponderosa pine, larch, and Douglas fir, showing woods and mill utilization of the average-sized tree of these species. The Ponderosa pine chart follows the next page of this report. A study of this chart indicates that 89% of the cubic volume is removed from the woods in the form of sawlogs or left in the woods as cull logs too defective for manufacture into lumber. Of the 11% left in the woods, 2.8% is lost in the form of merchantable breakage. At the present time it is not known how much of this 2.8% is unavoidable, but casual observation indicates that a portion of it can be avoided. In addition to this breakage loss, eight-tenths of one per cent of the tree is left in the stump in the form of usable material and 1.4% of the tree is left in the form of smooth and straight material in tops. Of the sawlogs taken out of the woods, 67% of their cubic contents goes into lumber while the remaining 33% goes into by-products and absolute waste as indicated on the chart.

As previously indicated, wood losses in logging the larch-Douglas fir type are next in volume to the losses encountered in the white pine type. A cruise of the larch long butt material in this type available for galactan extraction was made. During the normal year it is estimated that from 8,000 to 10,000 cords of larch long butt material are left in the woods, mostly tributary to the Great Northern Railway in northwestern Montana. Some of this material is, of course, subsequently used for fuel wood, so it is not wasted. Material in stumps is also suitable for galactan extraction. By cutting stumps reasonably sound, except for shake and check, to an average height of seven inches, an additional 5,000 cords per annum could be secured from this same territory.

The aggregate loss for this Region in converting white pine, Ponderosa pine, larch, and Douglas fir to lumber and timbers is considerable. Each year the wood losses encountered in logging and milling these four species would pave the Northern Pacific Railway track between the rails with blocks of one cubic foot each from Chicago to Seattle.

Depreciation Studies

A study in fire-killed white pine lumber in northern Idaho to determine the depreciation in the quality and quantity of the lumber showed that if the timber could not be logged and manufactured into lumber within two years after it had been fire damaged it could not be salvaged at a profit. The one-year-old fire-damaged white pine logs lost 10% and the two-year-old fire-damaged logs lost 16% in their lumber sale value.

As a part of the log bucking for grade study, fire-damaged Ponderosa pine butt logs were compared on a value basis with sound butt logs of a similar diameter, log grade, and taper. From these data the loss from fire damage by tree d.b.h. classes was computed and applied to an average of two logging areas on the Flathead Indian Reservation. This stand contained 5.97 fire-damaged trees per acre, each suffering a loss of $1.81 in lumber selling value. The trees, sound or containing defects other than those due to fire, numbered 19.98, valued at $19.25 each, based on average annual lumber selling values for 1928. The average selling value loss per acre is then computed to be $5.97 x $1.81 or $10.78 per acre. This is not a theoretical loss but a measurable loss caused by recurring fires during the past century or so. The importance and seriousness of this loss can best be illustrated by computing the loss sustained by a given logging unit.

The Camas logging unit on the Flathead Indian Reservation contains approximately 120 million feet of timber on about 12,000 acres. It is assumed that depreciation from fires during the past century or so has been the same on this area as on the Revais and Valley Creek unit, where the foregoing fire-damaged stand figures were obtained.

According to Forest Service and Timber Protective Association figures, five cents per acre over a long period will be ample for fire protection, or a cost of $600 per year for this area. The average yearly depreciation of this timber during the past century or so has been at the rate of $10.78 per acre or $129,360 for an assumed period of 120 years. This period is used because available growth figures on residual stands indicate that cut-over areas similar to those on Lynch Creek near Plains and the old A. C. M. cuttings surrounding Potomac will, no doubt, produce a volume equal to the yield of our present virgin stands in 120 years if given proper fire protection. The average yearly depreciation of this timber during a 120-year period is then $129,360 divided by 120 or $1,078 per year. Thus, the annual net amount that could be saved by protection would be $478. The $478 illustrates one of the financial aspects in the protection of Ponderosa pine cut-over areas well stocked with advance growth.

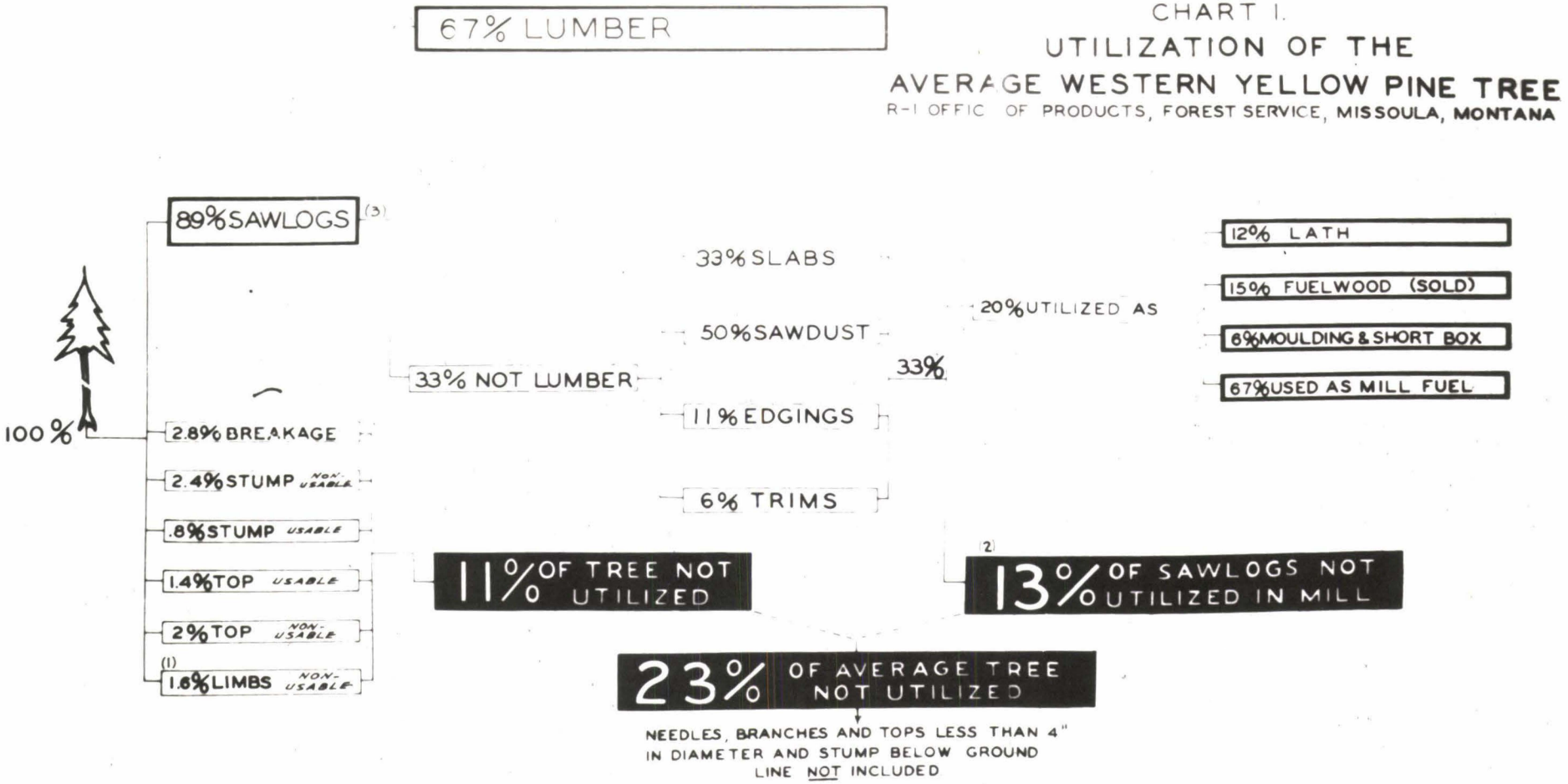
Wood Preservation

Information resulting from actual experiments in treating with preservatives the various kinds of woods growing within this Region has been used as the basis (1) for present specifications for the treatment of timbers in Forest Service improvement work;

Between 32 + 33

CHART I.
UTILIZATION OF THE AVERAGE WESTERN YELLOW PINE TREE

R-1 OFFIC OF PRODUCTS, FOREST SERVICE, MISSOULA, MONTANA



THE AVERAGE WESTERN YELLOW PINE TREE LOGGED IN NORTH IDAHO AND WESTERN MONTANA IS 23" IN DIAMETER BREAST HIGH

(1) INCLUDES LIMBWOOD OF MINIMUM DIMENSIONS OF 4" MIDDLE DIAMETER OUTSIDE BARK AND 4 FEET IN LENGTH

(2) THIS INDICATES 13% OF SAWLOGS ARE ABSOLUTE WASTE IN MILL - NOT 13% OF ENTIRE TREE - 12% (13% X 89%) IS ABSOLUTE WASTE IN MILL

(3) BASED ON MILL UTILIZATION IN 1925

(2) For the design and use of an efficient open-tank apparatus for treating posts, poles, and timbers; (3) for recommendations to the public, followed in at least one instance by the establishment of an efficient treating plant used cooperatively by the Service and the ranch owners.

There follows a brief discussion of the results obtained in some of the recent experiments:

Life of Untreated Western Red Cedar: In 1915 and 1916, when equipping its railway line for operation by electric power between the stations of Harlowton, Montana, and Avery, Idaho, the C. M. St. P. & P. Railroad Company installed 30,748 untreated western red cedar trolley and transmission poles. In the fall of 1922 the railroad company and the Forest Service entered into a cooperative agreement to determine the condition of these poles as affected by decay and secure information for use in future maintenance work. The following table shows the total number of poles which had been reinforced at the end of 1930:

Total Number of Poles Originally Set		Stubbed on Account of Decay, 1922-30	
		Number	Per Cent
Trolley	23,879	8,454	35.40
Transmission	6,869	2,017	29.36
Total	30,748	10,471	34.05

The results of inspection and maintenance work from 1922 to 1930, including description of tests applied to poles before stubbing, specifications for the treated stubs used and other data of value to both the Forest Service and the cooperators, were summarized by Whitney in a report completed on July 1, 1931.

Figures from the railroad company as to the comparative cost of stubbing and setting new poles indicate very plainly the economy of the stubbing done in this case.

Study of Ananconda Wood Preservative: The effectiveness of Cold Treater Dust, Granulated Treater Dust, and Anaconda Wood Preservative Paste, which contain from 60 to 80 per cent arsenic trioxide (AS_2O_3) is being tested in this Region through experimental treatments of telephone stubs, fence posts and poles. Methods of application prescribed by the manufacturers have been used and each installation includes some untreated material of the same species, set under similar conditions of service for comparison. In a number of cases the service records of these arsenic-treated timbers are obtained through the Forest Supervisors.

Information from an inspection of 774 treated and 94 untreated poles in the telephone line from King's Hill to Musselshell Ranger Station in the Lewis & Clark Forest in October, 1931, is presented in the following summary:

Treating Conditions and Results with Various Forms of
Anaconda Wood Preservative
Lodgepole Pine and Douglas Fir Poles (1)

Preservative	No. of Poles Set	Date Set	Yrs. Service	Condition of Poles: Sound No.	Sound %	Partly Decayed No.	Partly Decayed %	Badly Decayed (3) No.	Badly Decayed (3) %	Stubbed (4) No.	Stubbed (4) %
5 lbs. arsenic dust in holes (2)	238	Aug. Sept. 1926	5	64	26.9	55	23.1	110	46.2	9	3.8
Shaved & arsenic paste applied 1928 after 3 yrs. untreated	51	Fall 1925	6	5	9.8	8	15.7	30	58.8	8	15.7
5 lbs. granulated arsenic in holes (2)	485	Summer 1927	4¼	30	6.2	166	34.2	234	48.3	55	11.3
Total Treated	774			99	12.8	229	29.6	374	48.3	72	9.3
Untreated	94	S'27	4¼	3	3.2	3	3.2	88	93.6	0	

(1) Approximately 40% of all poles treated were Douglas fir and 60% lodgepole pine.
(2) The arsenic was put in the holes in three layers, near the bottom, about the middle of the fill, and again just under the surface.
(3) Poles in advanced and developed stages of decay to be stubbed in 1932.
(4) Poles reinforced with creosoted lodgepole pine stubs in 1931.

If treater dust or Anaconda Wood Preservative has afforded any protection to these poles it is scarcely distinguishable in the above records. The rate of decay has been very rapid. Of the treated poles, 72 were stubbed in 1931 and in addition, 374 treated and 88 untreated poles should be stubbed in 1932. In other words, about 57 per cent of all treated poles are shown to be in such poor condition as to require reinforcement after only four to six years of service. While one of the claims made for the treater dust or arsenic paste treatments is cheapness, an initial cost of 50¢ per pole for applying such treatments to the poles in this line has not proved to be a good investment.

Approximately one-third of the lodgepole pine stubs needed for the maintenance of this telephone line in 1931 and 1932 were treated by District Ranger Wilson in 1931 at a cost of 59.4¢ per stub for the preservative and labor in treating. These stubs were treated with a 40-60 mixture of creosote and gas oil at the new King's Hill treating plant, Lewis & Clark Forest.

Statistics on Forest Products

Current data are obtained on the amounts produced, production costs and selling values of the forest products cut and manufactured within the Region. The selling value of lumber by species and grades for the several districts, compiled by this section, is used in figuring the sale value of government-owned timber by the Forest Service in Washington, Oregon, Idaho, and Montana. Detailed lumber manufacturing costs are collected annually from 30 to 35 band mills of the Region. These cost data, as well as the selling value of lumber, are absolutely necessary in figuring the sale value of government timber.

The productive results of this project are best illustrated by the four exhibits that follow this page.

Exhibit 1 contains a preliminary statement of the 1930 lumber, lath and shingle production for Montana and Idaho. Similar statements are issued annually.

Exhibit 2 contains a compilation of average stumpage sale prices for 1930 by species for Montana and Idaho. Note the high price being paid for cedar stumpage due to scarcity of good pole material.

Exhibit 3 contains a compilation of the average lumber manufacturing costs for the Inland Empire mills. In 1918 it cost $9.80 to manufacture a thousand feet of lumber compared to $12.38 in 1930. In 1930 selling values were slightly lower than in 1918, which meant a very narrow operating margin in 1930 and sometimes none at all.

Exhibit 4 contains a graphic presentation of lumber selling values by species from 1913 to 1931. Prices for all species are lower now than at any time since the United States entered the World War.

Exhibit #1

PRODUCTION OF LUMBER, LATH, AND SHINGLES

IN IDAHO AND MONTANA, 1930

(Preliminary Statement based on returns from lumber census conducted jointly by the Bureau of the Census and the Forest Service.)

Lumber Sawed M feet Board Measure

(Mills cutting less than 50 M ft. during year excluded)

Species	Idaho	Montana	Combined Cut Volume	Combined Cut %
Idaho white pine	432,440	25,601	458,041	40.2
Western yellow pine	219,969	133,730	353,699	31.1
Western larch	56,284	77,889	134,173	11.7
Douglas fir	61,087	45,558	106,645	9.5
White fir	53,116	70	53,186	4.6
Spruce	7,970	13,343	21,313	1.9
Cedar	7,612	---	7,612	0.7
Lodgepole pine	1,017	764	1,781	0.2
All other	982	19	1,001°	0.1
Total	840,477	296,974	1,137,451	100.0
Lath, M pcs.	84,106	14,483	98,589	
Shingles, M pcs.	4,940	25	4,965	

°Includes 332 M hemlock and 669 M cottonwood.

Comparative total production M feet for the last ten years:

Year	Idaho	Montana	Total
1921	542,620	213,989	756,609
1922	857,581	303,458	1,161,039
1923	1,072,930	426,917	1,499,847
1924	1,017,960	350,335	1,368,295
1925	1,140,575	388,854	1,529,429
1926	947,471	378,698	1,326,169
1927	923,986	396,267	1,320,253
1928	977,468	387,879	1,365,347
1929	1,028,791	388,711	1,417,502
1930	840,477	296,974	1,137,451
Total	9,349,859	3,532,082	12,881,941
10-yr. av.	934,986	353,208	1,288,194

The effect of the demoralized lumber market is reflected in the lowest cut in 1930 since the slump of 1921. Idaho white pine was the only species that maintained its market position from a production standpoint.

Exhibit #2

STUMPAGE VALUES
1930
Per M Feet

SPECIES	U.S. Forest Service Region I	U.S. Indian Service Region I	Private		State	
			Idaho	Montana	Idaho	Montana
Western White Pine (green)	(35,654 M) $4.45	(no sales)	(35,902 M) $5.57	(241 M) $2.71	(1,000 M) $4.91	(no sales)
Western Yellow Pine	(6,410 M) $2.64	(43,584 M) $3.66	(15,214 M) $2.67	(29,791 M) $2.35	(555 M) $2.50	(22,501 M) $3.25
Cedar (Sawlogs, poles, etc.	(7,105 M) $11.28	(108 M) $6.58	(5,062 M) $6.87	(no sales)	(117 M) $10.45	(no sales)
Larch - Douglas Fir	(4,140 M) $1.44	(2,634 M) $1.79	(28,878 M) $0.57	(40,778 M) $1.58	(470 M) $1.46	(11,175 M) $3.00
Spruce	57 M) $1.04	(no sales)	(822 M) $0.58	(70 M) $1.79	(no sales)	(no sales)
Lodgepole Pine	(no sales)	(no sales)	(no sales)	(7 M) $2.86	(no sales)	(no sales)
Mixed	(660 M) $0.50	(no sales)	(254,065 M) $0.21	(no sales)	(115 M) $1.50	(no sales)
Average All Species (1930)	$4.85	$3.57	$2.21	$1.77	$3.71	$3.33
Average All Species (1929)	$3.83	$2.95	$3.69	$2.04	$5.03	$3.33

Exhibit #3

LUMBER MANUFACTURING COSTS
(Exclusive of Interest or Discount)

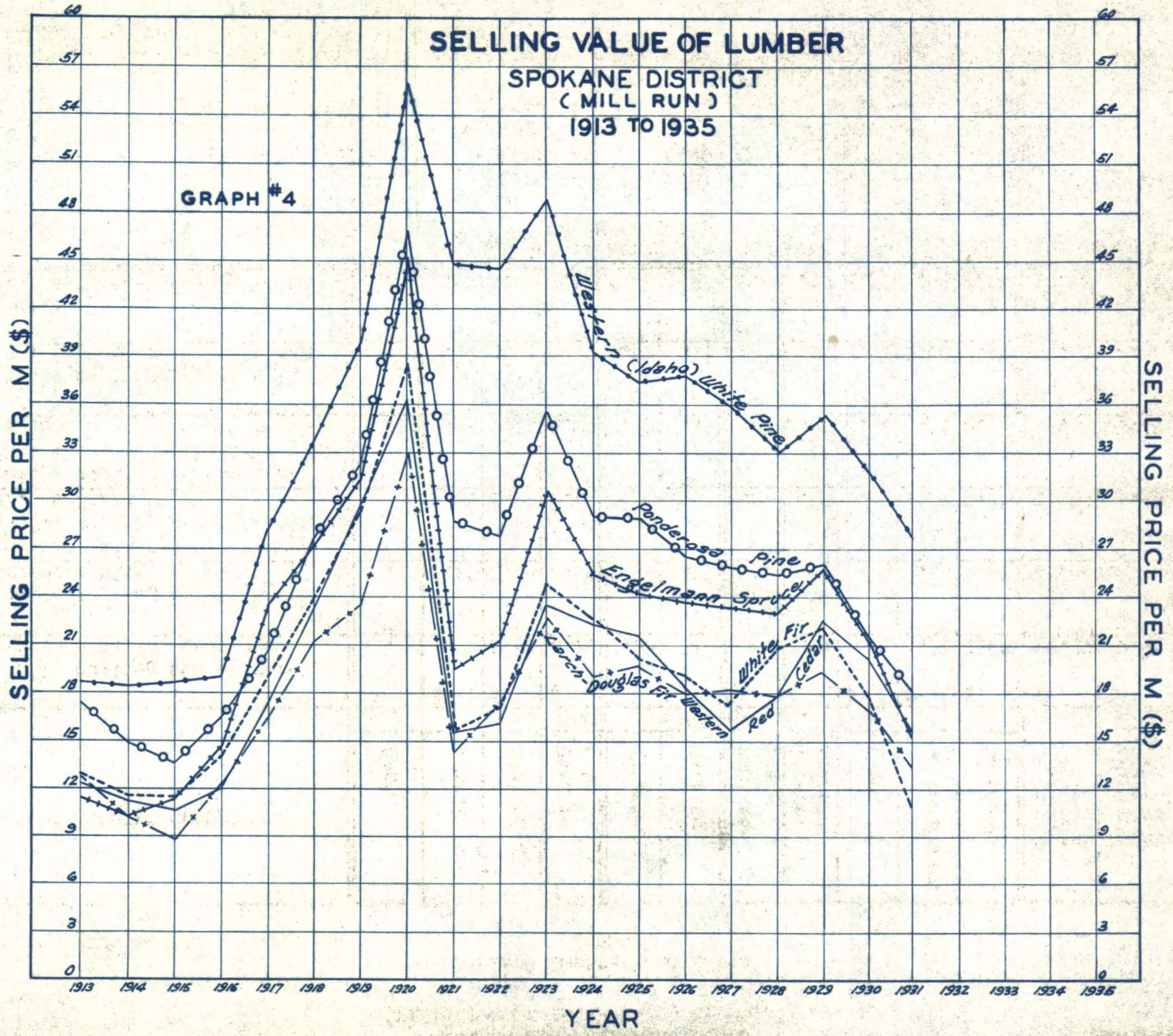
Inland Empire Band Mills
(1930)

MILL GROUPS	Pond	Sawmill	Yarding	Pond to Pile	Shipping	Selling	Pile to Car	General Expense	Taxes	Depreciation	Overhead	Total Mfg. Cost 1930	Total Mfg. Cost 1929
	Cost per M feet B.M.												
3 mills cutting 50% or more larch and D. fir combined	$ .18	$ 2.07	$ 1.46	$ 3.71	$ 2.95	$ .55	$ 3.50	$ 1.22	$ .51	$ 1.34	$ 3.07	$ 10.47	$ 9.90
6 mills cutting 50% or more Ponderosa pine	.12	2.20	1.34	3.66	2.96	1.53	4.49	1.67	.59	.62	2.88	11.36	10.18
10 mills cutting 50% or more I.W.P., spruce, cedar, white fir, combined	.14	1.82	1.21	3.17	3.68	1.53	5.21	1.87	.58	1.07	3.52	13.04	11.49
7 mills cutting 50% or more Idaho white and Ponderosa pine combined	.14	2.12	1.31	3.57	3.65	1.41	5.06	1.80	.42	1.01	3.23	12.50	11.49
4 mills cutting principally ties, timbers or match plank °	.14	1.78	.95	2.87	.82	.43	1.25	1.12	.86	1.06	3.04	7.16	5.33
24 mills, Total Weighted Average	.14	2.01	1.28	3.43	3.48	1.42	4.90	1.79	.52	.98	3.29	12.38	11.09

Average Annual Manufacturing Costs
(Per M feet B.M.)

1916 -- $ 6.50	1921 -- $ 13.81	1925 -- $ 10.97
1917 -- 7.90	1922 -- 10.79	1926 -- 11.08
1918 --- 9.80	1923 -- 11.75	1927 -- 11.18
1919 -- 10.99	1924 -- 11.71	1928 -- 11.22
1920 -- 13.13		1929 -- 11.09
		1930 -- 12.38

° Three of the four mills within this group produce commercial lumber also. Cost of producing this lumber is given in one of the groups above.


SELLING VALUE OF LUMBER
SPOKANE DISTRICT
(MILL RUN)
1913 TO 1935
GRAPH #4
SELLING PRICE PER M ($)
SELLING PRICE PER M ($)
YEAR
Western (Idaho) White Pine
Ponderosa Pine
Engelmann Spruce
White Fir
Larch-Douglas Fir Western
Red Cedar
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935

Extensive Revision

Information compiled in this project was requested for use of the Timber Conservation Board recently appointed by the President.

The figures showing the drain from lumbering, fire, insects, and disease for the states of Idaho and Montana are both interesting and useful to the lumber industry as well as forestry organizations. They are absolutely essential to us in balancing our present cutting budget with the future wood requirements.

Drain figures for Montana and Idaho follow:

Cause	Annual Drain, Million Feet B.M. (Lumber Tally)	
	Montana	Idaho
Cutting	448	1,170
Fire	228	204
Insects, Wind and Disease	267	208
Total	943	1,582

Montana forests can stand the above drain indefinitely provided the annual cut of Ponderosa pine does not increase. The situation is different in Idaho. The annual growth disregarding species is almost 200 million feet less than the present drain. The principal part of Idaho's lumber is produced from Ponderosa pine and Idaho white pine. Thus the continuation of the industry depends upon the remaining stands of these two species unless other species become profitable for operation in the future. If these other, or inferior, species do not materially increase in value to the point where logging is profitable, the present stand of the two pines will sustain the present cut from 15 to 20 years.

Forest Survey

The Forest Survey project has reached the stage for a final decision as to method to use. Both the strip method and the compilation method have desirable features.

Detailed study of existing cruise records and other available data for lands in all ownership has been completed. The amount and character of such data would seem to justify the use of the compilation method. This recommendation is strengthened by the almost universal demand that the Survey produce a map showing such things as type, age class, and accessibility.

Private timber cruise records were found to be surprisingly uniform in data taken. The records usually give by forty-acre units an estimate of amount of timber by species, logs per tree and logs per M, a description of timber quality and logging conditions and in many instances show burns, grass or brush, and reproduction. Most operating companies maintain rather detailed cut-over maps and records by either legal subdivisions or logging units.

Approximately 25% of the State land, nearly all of the Indian land, and all of the National Forest land upon which the timber is considered merchantable has been cruised. The record indicates that there is usable information on 90% of the merchantable timber lands, 40% of which will require field checking to insure a satisfactory standard of accuracy. In addition, 50% of the cut-over or burned-over lands have some usable data available.

The total timbered area to be covered by the Survey in the Inland Empire proper is approximately 24,019,000 acres. This area is made up of about 9,931,000 acres of merchantable timber, 9,212,000 acres of cut-over and burns, and the balance protection forest or grazing lands.

Range Research

The F. Y. 1932 appropriation of $10,000 for research at the U. S. Range Livestock Experiment Station in cooperation with the Bureau of Animal Industry and the Montana Agricultural Experiment Station is the first money available for range research in Region One since 1926. During the interim the Office of Range Management and certain administrative officers have contributed some time and effort to a few administrative grazing studies, projects which are being continued.

In view of the delayed start, reasons for which have already been stated, definite and tangible results of range research work to date are limited. Watts and Hurtt made an extended automobile trip through eastern Montana in November and found very badly disturbed economic conditions there. Thousands of dry farms are deserted and three years of drought have almost depopulated large regions of breeding stock. Native ranges are badly depleted by overgrazing and the plow. Wind and water erosion has reached alarming proportions in many places. A brief memorandum by Hurtt summarized the findings and recommendations of this rough survey.

Some time was spent getting acquainted with the situation and the facilities for range research work at the U. S. Range Livestock Experiment Station but it was too late to build the fences and water developments needed for the experimental work planned jointly with Mr. Chapline and Mr. Quesenberry of the U. S. Range Livestock Experiment Station. A series of twelve small pastures for carrying out range utilization tests will be fenced this spring with materials that are being assembled. Two wells must also be developed. Funds for the improvement phase of the problem are far too small. A working plan for this project is under preparation. It is planned to start in a

very limited way on the revegetation of overgrazed and plowed ranges and to start some work on improved finish or better market grades on range livestock and also breeding pastures and calf crop improvement through the use of segregation pastures.

EXPERIMENT STATION PERSONNEL

Lyle F. Watts. . . . . Director

Forest Management

R. H. Weidman	Sr. Silviculturist	Silviculture
I. T. Haig	Assoc. "	
H. T. Gisborne	Silviculturist	Fire Research
L. G. Hornby	Reg. For. Inspector	
G. M. Jemison	Jr. Forester	
J. B. Thompson	Jr. Forester, Priest River Branch Sta.	

Range Research

L. C. Hurtt	Assoc. Range Examiner
_____	Jr. " "

Forest Products

M. I. Bradner	Sr. Forester
I. V. Anderson	Assoc. "
C. N. Whitney	Asst. "

Forest Survey

M. I. Bradner	Sr. Forester
G. M. DeJarnette	Asst. "
_____	Jr. Forester or Asst. Timber Expert

Clerical

M. J. Pershina	Chief Clerk
L. J. Hinton	Clerk-Stenographer
_____	Stenographer

Regional Assignees

W. I. White	Fire Research
H. R. Richards	

EXPENDITURES F. Y. 1932
(Estimated to 6-30-32)

Lines of Work	Research Funds	Regional Contribution	Census & Coop. Funds
Forest Management			
Botany B-1	840		
Management			
M-1	10,960	1,074	21
Mt-1	915		
Special	1,005		
Mensuration			
ME-1	1,280		
Protection			
Pf-1	11,780	9,147	
Pf-2	7,120	250	
Total	33,900		
Range Research	9,100		
Forest Survey	18,000		
Forest Products			
Logging & Milling (including Woods & Mill Waste)	6,060	915	
Wood Preservation	1,007		
Species Utilization	1,221		
Statistics	3,852	620	1,000
Special Studies	770		
Total	12,910		
GRAND TOTAL	73,910	12,006	1,021

Form No. 1

RESEARCH PROJECT ALLOTMENT SHEET

Northern Rocky Mountain Forest & Range Experiment Station

Fiscal Year 1933

Sub-Appropriations and Projects	Research Allotment	Region Contributions	Cooperative Funds			
			Other Bureaus	State	County	Other
			Census			
Forest Management		1,415°				
B-1 Botany	1,650					
M-1 Management White Pine	11,460	600 C.T.				
Mt-1 Thinning White Pine	1,065					
ME-1 Mensuration White Pine	825					
ME-2 " Larch-fir						
Pf-1 Attack	14,500	9000 C.T.				
Pf-2 Behavior	5,100	200 C.T.				
TOTAL	34,600	11,215				
Range Investigations						
Mgt. Short grass ranges	9,400					
Forest Economics						
Forest Survey - Idaho	14,500					
Forest Products						
Logging & Milling Studies)						
Wood & Mill Utilization)	6,150	750 C.T.				
Wood Preservation	900					
Species Utilization	1,500					
Statistics	4,100	600 C.T.	700			
Special Studies	1,560					
TOTAL	14,210	1,350	700			

° - This Regional contribution is for maintenance of Priest River improvements ($925) and for miscellaneous expenses such as forage, fuel, etc. ($490) at Priest River, included on Form 2.

Balance of Regional contribution is contributed time on projects. Pf-1 may include expenses of detailed or assigned men not shown on Form 2.

Form No. 3

Estimated Distribution of Direct
and Overhead Expenditures

Northern Rocky Mountain Forest and Range Experiment Station

Fiscal Year 1933

Sub-Appropriation	Direct	Overhead	Total
Forest Management	29,278	5,322	34,600
Range Investigations	8,066	1,334	9,400
Forest Products	11,993	2,217	14,210
Forest Survey	12,283	2,217	14,500
Forest Economics			
Erosion & Streamflow			
F. F. Cooperation			
TOTAL	61,620	11,090	72,710

15.2% of all funds (direct Research appropriations only) is used for overhead, which includes 11 months of Watts' salary, one-third of Hinton's salary, all of Pershina's and stenographer's salaries, Watts' travel, and a reasonable amount for such items as Freight, express, & drayage, Supplies & equipment, Telegraph, telephone, & postage, and $750 for a station car.

PUBLICATIONS

Published Since Last Report

1. Lumber, Lath and Shingle Production in Montana and Idaho in 1930. C. N. Whitney. Press release.

2. A Sawed Tie Volume Table for Western Larch and Douglas Fir. I. V. Anderson. West Coast Lumberman.

3. The Stocked-Quadrat Method of Sampling Reproduction Stands. I. T. Haig. Journal of Forestry, May, 1931.

4. Stand Tables for Second Growth Western White Pine. I. T. Haig. Northwest Science, December, 1931.

5. A Five-Year Record of Lightning Storms and Forest Fires. H. T. Gisborne. Monthly Weather Review, April, 1931.

6. Lightning on the Lookouts. H. T. Gisborne. American Forests, September, 1931.

7. The Scheme of Forest Fire Control. H. T. Gisborne. Journal of Forestry, November, 1931.

8. Phases of Fire Problem. H. T. Gisborne. American Lumberman, November 28, 1931.

Submitted For Publication

1. Properties and Uses of Western Larch. R. P. A. Johnson and M. Bradner. Department Bulletin. Submitted to Forester. Accepted for publication.

2. An Analysis of Log Production in the Inland Empire. M. Bradner, F. J. Klobucher, J. W. Girard, and S. V. Fullaway. Department Bulletin. Submitted to Forester.

3. Residual Wood After Logging in the Western White Pine Region. I. V. Anderson. Timberman - awaiting arrangements for publication.

4. Residual Wood After Logging in the Ponderosa Pine Type. I. V. Anderson. Timberman - awaiting arrangements for publication.

5. Residual Wood After Logging in the Larch-Douglas Fir and Lodgepole Pine Types. I. V. Anderson. Timberman - awaiting arrangements for publication.

6. Woods and Mill Utilization, North Idaho and Western Montana. I. V. Anderson. Journal of Forestry - in editor's hands awaiting arrangements for publication.

7. Timber Growing and Logging Practice in Western Yellow Pine in the Northwest. R. H. Weidman. Revised manuscript. U. S. D. A. Bulletin.

8. Some Climatic Effects on Forest Stands and Forest Types. R. H. Weidman. Northwest Science.

9. Conifers of the Northern Rocky Mountains. J. A. Larsen. Revised manuscript. U. S. D. A. Bulletin.

10. Yield, Stand and Volume Tables for Second Growth Western White Pine. I. T. Haig. U. S. D. A. Bulletin.

11. Comparative Timber Yields. I. T. Haig. Journal of Forestry.

12. Note on Seed Germination During Natural Storage in Duff. I. T. Haig. Ecology.

13. Growth and Yield of Western White Pine. I. T. Haig. Timberman.

14. Recovery, Growth and Treatment of Understory Hemlock Released by Logging in the Western White Pine Type. I. T. Haig. Journal of Forestry.

15. Meteorological Factors Affecting Freeman Lake Fire. G. M. Jemison. Monthly Weather Review.

In Preparation or Proposed for F. Y. 1933

1. Breakage Losses in Felling Important Trees of the Inland Empire. I. V. Anderson. Applied Forestry Notes.

2. Properties and Uses of Lodgepole Pine. C. N. Whitney. Department Bulletin.

3. Volume Table for Pondosa Pine. I. V. Anderson. Timberman.

4. A Second Cutting of Ponderosa Pine in Western Montana - Results of Accidental Selective Logging Forty Years Ago. I. V. Anderson West Coast Lumberman.

5. A Silvicultural Study of Western White Pine. R. H. Weidman and I. T. Haig. U. S. D. A. Bulletin.

6. Sources of Regeneration Following Fires in the Western White Pine Forest. R. H. Weidman. Journal of Forestry.

7. Results of Thinning Experiments in the Western White Pine Type. R. H. Weidman. Progress Report.

8. Some Aspects of Succession in the Western Yellow Pine Forest. R. H. Weidman. Ecology.

9. Guide to Experiments and Sample Plots at the Priest River Experimental Forest. R. H. Weidman. U. S. D. A. Miscellaneous Publication.

10. Reproduction and Residual Growth on Cut-over Areas in the Western White Pine Type. I. T. Haig. Final Report.

11. The Effect of Stand Composition on Yield in the Western White Pine Type. I. T. Haig. Article.

12. The Effect of Stand Composition, Site and Other Factors on Tree Volume in the Western White Pine Type. I. T. Haig. Article.

13. Climatological Summary for the Priest River Forest Experiment Station. G. M. Jemison. To be mimeographed.

14. The Principles of Fire Control in the Northern Rocky Mountain Region. L. G. Hornby and H. T. Gisborne. To be mimeographed for first distribution to the Forest Service, then rewritten for publication as a Department Bulletin.

REPORT OF REGION ONE INVESTIGATIVE PROJECTS

(1931)

Artificial Reforestation

Not only was there definite progress made in the going projects with gratifying results, but several extra projects were undertaken that yielded results indicative of a definite trend.

Seed Studies

Under this section last year was mentioned a series of studies just gotten under way. Further work through the year has given the following results:

1. Time of Ripening of Cones: Seeds from cones collected from the same trees at weekly intervals from July 23 to the last of August in 1930 gave higher germination as the season advanced. Both Douglas fir and Engelmann spruce seed from the first collection (July 23) gave some germination, although very little. Seeds from yellow pine and larch did not germinate until the August 14 collection. As stated in last year's report, white pine cones collected before August 14 "set" and could not be opened by drying methods to remove the seed, consequently early collection of this species was of no practical value, regardless of the viability of the seed.

2. Dissemination of Seed: There has been considerable speculation as to the possibilities of some seed being held in the cones on trees through part or all of the winter following ripening of the seed. It is quite generally believed that all seed is released the same fall the cones ripen. Recent studies tend to disprove this notion. White pine and yellow pine cones on the trees were covered with large screen cages in the fall of 1930. The cones were on the periphery of the crown, subject to wind and sun. The screen cages did not appreciably affect sun or wind action on drying because these cones opened normally as compared with the unprotected cones nearby. The following summarizes the seed release until the cones dropped from the branches:

	White Pine		Yellow Pine	
	Hollow Seed	Good Seed	Hollow Seed	Good Seed
September 24			3	
October 29	4	4		9
December 4	1		5	3
February 8		10		
April 9			5	1
May 12	16	84	9	62
June 16			34	10
June 20	13	68		
October 6			15	2
TOTALS	34	166	71	87

3. Germinative Capacity of Seed Produced from Young Trees: Most of our species in this region commonly bear cones when 15-20 years of age. Rare cases of trees bearing cones at 8 and 10 years have been found. Yellow pine seems to be the slowest to bear fruit, the youngest recorded being 14 years old and cones are not commonly found on this species until 25-30 years of age. A series of tests made last winter gave the following results:

White Pine. Nine tests (600 seeds each) from trees 10 to 26 years old showed germination to be from 26½ to 58½ per cent. The average was close enough to that of our regular collections to be equal after making allowances for machine grading which can not be done with experimental lots.

Tests of yellow pine seed gave 81% germination for seed from a 14-year-old tree; 70% from trees 0-20 years; 92⅓% from trees 20-40 years; 66% from trees 60-80 years. These percentages are all higher than that of the seed gathered in large quantities from mixed ages in the regular collections.

4. Effect of High Temperatures on Germinative Capacity of Seed: In this region white pine and Engelmann spruce cones are dried for extraction purposes by artificial means. The maximum temperature used for drying cones has been 110°, with a limit of 120° permitted only for short duration. Naturally, the higher the temperature the quicker the cones can be opened. Occasionally the temperature has run as high as 140° in the kilns. In a few instances sowings of white pine seed at Savenac has resulted in no germination and the cause attributed to over-heating of seed.

Seventy-two samples of 200 seed each of white pine seed were heated in a soil oven at temperatures varying from 120°F to 180°F and for periods of from 5 minutes to 5 hours. These tests are not complete, but to date germination of the seeds subject to the higher temperatures is equal to that of seeds heated only moderately. Viability of white pine seed is not destroyed by a temperature of 180°F maintained for one hour.

However, with a similar completed test of Engelmann spruce seed, there is a decided lowering of viability when subjected to 160° or more and viability is practically destroyed when the seed is subjected to 180° for one hour.

5. Climatic Races of Engelmann Spruce Seed: There is little to report at this time on the study of climatic races in Engelmann spruce. Nine lots of seed were collected in various localities in this region at altitudes ranging from 2400 to 7000 feet. The seeds have been sowed in the nursery and the stock is now one year old. Beginning this spring observations will start on the frost hardiness and growth in the nursery of the various lots. Later the study will be carried to the plantations.

6. The administrative germination tests, of which there were many last year, brought out a number of important points.

Fifteen per cent of the total germination in white pine occurred after 200 days. The 200-day test has in the past been considered practically complete. Engelmann spruce seed was thought to be one of the most prompt to germinate. A 60-day test has been considered sufficiently

accurate and the peak of the germination period between 25 and 35 days after the installation. In the four lots tested last spring there was as usual a pronounced acceleration in germination 25 days after sowing and thereafter for several months the curve held almost level but about 100 days after sowing germination again accelerated and continued for two months, bringing the total germination in a 187-day test to almost 10 times the amount occurring in a 60-day test. This surprising delay in germination of spruce seed is quite likely the cause of frequent overstocking in the nursery spruce beds.

Nursery Studies

Work continued on the extensive "fact-finding campaign" started several years ago to determine extent of losses occurring in the seedling and transplant beds, to classify such losses as to causes, known and unknown, and to find remedies to reduce the heavy losses. Numerous counting frames and observation plots were again installed in the new beds. The greatest loss again occurred in the one-year-old white pine seed beds. However, it is believed that the cause has now been determined and in the future this loss may be greatly reduced. Instead of the seedlings being weakened by under-nourishment as had been supposed, this condition, it is believed, results from root rot working an inch below the surface, and according to Dr. Hubert, who gave considerable time last spring to the study, is perhaps due to the heavy treatments of dried blood fertilizer used in seedling culture at Savenac.

Millions of white pine seedlings have died from the effects of this root rot in the last few years, and in an attempt to determine the cause, most efforts were misdirected toward improving the soil fertility and studying the relation of soil acidity to the development of the seedlings. The weakened condition of the seedlings did not become manifest until midsummer and early fall. Last spring it was accidentally found that the radicles of the white pines rotted off shortly after germination. But few seedlings succumbed at this stage. However, as summer advanced with hotter weather, the seedlings that had not adequately re-established themselves, paled, turned brown, and eventually died. The customary check plots of beds under various treatments made it possible to compare the effects from heavily fertilized beds and the controls. These indicated that the dried blood treatment caused the heavy infection of the root rot disease.

Planting

1. Grassy Bottom Land Planting: The principal active planting project is the survival study on grassy bottom land planting. Several installations had been previously made but the conditions of the ground selected were not entirely satisfactory. Also the stock used varied a great deal in quality between species. The installation made last year was satisfactory in every respect. The test included two series of 800 plants each, one series planted in patches of ground from which the sod had been removed and the other in soddy ground. Each series contained 200 trees of four species.

Although this experiment, as all other planting in the region, suffered from drought in 1931, comparative results are indicative. Survival of all species combined was 25% on the plots that had the sod removed and 5½% on planting in the sod. The ratio by species was about the same.

	Per Cent Living	
	Sod Removed	In Sod
White Pine	22	5
Yellow Pine	43	9½
Engelmann Spruce	22	6½
Douglas Fir	14	2

It is expected that the heavy sod will close in on the seedlings in three years' time. Whether or not they will have become sufficiently established to withstand the competition of grass is yet to be determined.

2. Ribes Suppression by Spruce Planting: Somewhat related to the above project is another kind of bottom-land planting undertaken last year. About a thousand spruce trees were set out in a patch of ground severely burned to effect Ribes eradication. The object of this planting is to determine the time required for reasonably closely spaced spruce to shade the ground sufficiently to prevent Ribes establishment.

3. Size of Stock: The study of age classes best suited for planting seems to be a never-ending project. In spite of the vast amount of work already done, new questions are continually bobbing up. Last year a series of yellow pine age classes was planted to determine the practicability of planting one-year-old stock on selected sites. If selected one-year-old stock can be established on selected sites at the same cost of planting larger stock on average sites, we will have a means of quickly expanding field planting and maintaining an enlarged planting program until more suitable stock can be produced in larger quantities at the nursery. Planting as an unemployment relief measure and the possibility of permanent planting expansion in Region One have given impetus to this study.

Survival counts could not be made last fall owing to the difficulty in finding the staked plots in the weeds. Examinations will be simpler this coming spring.

New installations of this sort will be made again this spring, including a new age class, 1-1 stock. Last year a block of a million transplants was developed into what appears to be unusually fine planting stock at this age. In root development, balance, and all other outward appearances this is far better stock than the larger top-heavy 1-2 class. Should survival of this stock meet expectations and development of similar stock be possible in the future, a great reduction in cost of stock and cost of planting will have been accomplished as well as a reduction of one year's time in producing suitable planting stock.

4. Spacing in Plantations: The spacing plots for yellow pine are complete. There is now an acre of each at 6x6, 8x8, 10x10, and 14x14 spacing. The last was added in the fall of 1931. Fail spaces in the other three were replanted last fall.

No suitable location has been found for the white pine spacing plots.

5. Artificial Pruning: Growth measurements were made of the trees in the artificial pruning plot. The data have not been compiled.

Publications

A bibliography on artificial reforestation containing approximately 1000 references was prepared during the year and 200 mimeographed copies distributed.

Forest Management

Progress by the Regional Office of Forest Management on research projects during 1931 was less than in previous years. Reductions in both Regional and National Forest personnel assigned to forest management activities has eliminated much of the time formerly available for this type of work. This fact coupled with the abnormally severe 1931 fire season precluded the use of more than the very minimum of time for research work. The necessary assignment of all available men to fire suppression call during July and August delayed other urgent work which had to be caught up during the fall work period.

Four projects are under way and will be pushed forward as opportunity affords.

ME - R-1. To determine rate of growth of residual stands after various kinds of cutting.

ME-161 - R-1. The construction of a Douglas fir volume table applicable to eastern Montana conditions.

Mr-101 - R-1. The encroachment of Ponderosa pine reproduction on grass lands.

Mt-101 - R-1. Determination of proper degree and system of thinning Ponderosa pine.

Range Management

The following progress on administrative range investigation during 1931 has been made by the Office of Range Management or by the National Forests under direction of that office:

1. Carrying Capacity - Poker Jim Experimental Pasture - Custer National Forest: Records have been obtained of carrying capacity, volume production, salting, losses, utilization and methods of measuring carrying capacity.

2. Carrying Capacity - Crow Creek Experimental Pasture - Helena National Forest: Records of carrying capacity and salt consumption.

3. Artificial Reseeding - Lewis and Clark National Forest: Records made in both field and check plots.

4. Growth Development and Extension of Range Plants: Records on 52 plots were obtained. Drought prevented germination of nearly all species during spring and summer. Lolium perenne made the best growth during the drought period. All species germinated following fall rains.

5. Handling stock - Gallatin National Forest: Full data obtained. Additional controlled study plots added during 1931.

6. Carrying capacity: Results of special studies obtained on Gallatin, Nezperce, Jefferson, and Beartooth Forests.

Fire Control

The Regional Office of Operation is carrying no formal research projects but is cooperating with the Experiment Station on several studies. During 1931 approximately $9221 in assigned personnel and expense was made available to the Experiment Station for the hour control, man-power placement and transportation work.

REPORT OF BUREAU OF ENTOMOLOGY
Forest Insect Station, Coeur d'Alene, Idaho

The seriousness of the barkbeetle situation existing within the forests of Region One for the last few years is fully appreciated by all those familiar with conditions. Outbreaks of the mountain pine beetle in our white pine and lodgepole pine forests have destroyed and are still destroying tremendous volumes of timber. The economic importance of this problem has resulted in practically the entire investigative strength of the Coeur d'Alene station being concentrated upon it. This problem is being studied with the idea of developing more effective and economical methods of control, as well as to secure a better understanding of the application of control and the relationship which it has to the environmental factors of the region concerned.

In this study it has been necessary to not only conduct series of detailed tests relative to various methods of treatment, but it was very apparent that a better knowledge of the basic fundamentals of these problems was necessary in order that methods of control could be built upon a sounder foundation. Therefore, considerable time has been devoted to the study of seasonal histories, habits, parasites and predators, associated insects, etc., of these destructive barkbeetles.

In developing a method of control, one must consider such factors as its effectiveness in eliminating the destructive pest, its relation to beneficial parasites and predators, its feasibility, and necessarily the cost of its application. The chief criticism which is offered against present methods is that they are laborious and expensive, and it is hoped that from a thorough study of the application of our present methods a reduction can be made in the expense of operation and eliminate part of this objection. Unfortunately, the human element enters strongly into the effectiveness of any method of barkbeetle control. Employees by becoming derelict in their duty can effectively turn an otherwise successful project into a failure, and the methods of control are often considered at fault. The field of investigation relative to the solution of these problems therefore involves not only an entomological study, but one of economics as well. Though we have no startling innovations to announce, valuable information has been secured which is not only adaptable in our work, but will be of service in leading further investigations. A resume of the status of the investigative projects assigned to the Coeur d'Alene station follows:

Artificial Control of the Mountain Pine Beetle

All other suggested leads having been previously exhausted, the work on this project during the 1931 season was confined to lodgepole pine and white pine in what has become known as tree medication experiments. Infested lodgepole pine and white pine were treated with different strength solutions of sodium arsenate. With some trees both wood alcohol and denatured alcohol were used in different quantities in the hope that they would serve as a solvent to the pitch within the cellular structure and result in a more even distribution of the poison, which in past experiments has been a difficult condition to secure. During the 1930 season a rather large number of infested lodgepole were treated with different poisons. An examination of part of these trees in the fall of 1930 showed all treatment to be very unsatisfactory. Distribution of the poison had been unequal, and the outlook for success was discouraging. However, in the spring of 1931 the remaining trees were examined and those which had been treated with sodium arsenate showed a 100 per cent mortality of the insect broods. Apparently the poison has set up some abnormal chemical condition within the tree which, though fatal to the developing broods of insects, was slow in its lethal effects. Final data relative to the treatments made this season will not be available until the spring of 1932. Though a satisfactory method of injecting this poison has been developed, it is still rather difficult in its application, and requires a certain amount of care and skill. A shallow saw kerf is made around the tree and a tin collar tacked below, serving as a cup into which the poisonous solution is poured. At the present it would seem that this potential method of control has its greatest field in the treatment of white pine, where the cost per tree under our present system is sufficiently high to permit a substantial reduction in the cost of treatment.

In addition to these experiments, a series of examinations were made of trees treated with the burning-standing method of control in order to determine its effectiveness. Though these data have not been thoroughly

analyzed, it is very evident that the method is only effective to a height to which the bark can be blackened by the flames. A sharp difference in the mortality of the insect broods exists between the blackened and unburned portions of the tree. As it is impossible to determine the height to which a tree is infested, it is necessary to fell for treatment all trees which can not be burned to a 6 or 8 inch top, if a thorough treatment is to be made. This necessary departure from previous practice increases the cost of this method of control.

Barkbeetle Control

This project is separated from the preceding one in that it deals with the economic phases of barkbeetle control. During the past season an attempt was made to study the going control projects with the idea of securing data relative to improvements in organization, technique, etc. However, our control program has been so heavy and our efforts diverted over such a large field that very little was accomplished. However, marked progress was made on the part of Forests carrying these projects in their organization, equipment, etc.

From a study of each project, the need for the placing of greater emphasis upon the quality of the work rather than quantity became apparent. This premise is based upon the fact that, if the results of control are not destroyed through flights of insects into the control unit, a clean-up of an infestation should be possible in one year instead of three or more as now seems to be required. The potential danger of trees missed by spotting and treating crews has been underestimated, and it is apparent that in many projects sufficient infested bark surface has been left untreated to rebuild the infestation back to a point requiring follow-up treatment for two, three or more years. A larger expenditure for a thorough clean-up, eliminating the necessity for follow-up work the following season, will, I am sure, prove to be the most economical practice to follow.

To learn more of the dissemination of forest insects, particularly barkbeetles, airplane traps were used in connection with an aerial survey of the Yellowstone Park, and plans formulated for their use in connection with fire patrol later in the season. Though during this survey a number of different insects were taken at varying elevations, no barkbeetles were secured. However, at the time this survey was made the mountain pine beetle had not started to emerge, so it was not to be expected that this species would be secured. Due to the severe fire season it was found to be impracticable to use the traps in connection with fire patrol, though it is hoped that during the coming season a few special flights can be made over designated areas and at a time when the new attacks are occurring. Two weather vane insect traps were made and set on lookout peaks on the Coeur d'Alene and Kaniksu. A number of barkbeetles, including the mountain pine beetle, were taken in these traps, showing that they do fly over timberless mountain tops, apparently following air currents.

The Beaverhead insect survey was again conducted, and valuable information contributed to our present knowledge of the spread of the mountain pine beetle, period of time over which the new attacks occur, severity of the devastation, and number of years required for an epidemic to sweep through an area.

Biology of the Mountain Pine Beetle in Its Principal Hosts

To answer some of the many complexing questions constantly arising in connection with instruction to spotters, etc., and to assist in the development of more efficient control measures, the apparently abnormal seasonal history events of the mountain pine beetle have been thoroughly studied during the past season. This investigation will be completed in the spring of 1932, and final data secured. Through a series of caging experiments, controlled by field observations, it was definitely proved that during the season of 1931 the attacking beetles emerged from their first host and reattacked another, producing successful broods in both trees. It is not known if a second re-emergence and third attack is made by these parent beetles, though this point will be clarified early in the 1932 season. This habit of re-emergence enhances the potential dangers of trees missed during control operations, and emphasizes more clearly the need for more careful clean-up in control work. Information was secured relative to such items as sex ratio, parthenogenesis, feeding and mating habits, etc., which are of value in contributing towards a better understanding of the problem.

Douglas Fir Beetle Investigations

This project includes a complete study of this insect, with the development of a satisfactory method of control as the primary objective. As this investigation has only been underway for one season, there is not a great deal to be reported. Satisfactory progress has been made in studies of seasonal history, parasites and predators, re-emergence and attack of parent adults, sex ratio, etc., though more time will be required before a final report can be given. The habit of re-emergence and attack of the parent adult beetles is practically the same as the mountain pine beetle.

Biology of the Oregon Pine Engraver (Ips Oregoni) and Associated Insects

From time to time this insect appears in an epidemic status in lodgepole pine and yellow pine reproduction and small trees up to several inches in diameter. Though our experience has shown that these outbreaks are of rather short duration, it often happens that severe devastation occurs during this period. The purpose of this study is to learn more of the factors which contribute toward the development and cessation of these sporadic outbreaks, as well as the development of artificial control methods. The past season has been devoted primarily to the seasonal history of this insect, with very satisfactory results. During the past season there were at least four generations of this insect, which were complicated by the overlapping of broods due to parent adult emergence, etc. Further work will be necessary before these complicating factors can be clarified and the most advantageous time for the institution of control determined.

The interrelation of outbreaks of this insect with accumulations of slash, fire-scorched timber, windfalls, etc., is being studied with the idea of avoiding insofar as possible such conditions favorable to outbreaks.

Insects and Forest Fires

The phase of this economically important problem which the Coeur d'Alene station has been permitted to study has been the interrelation of fire-scorched yellow pine and subsequent insect damage. This study was instituted for the purpose of securing a better understanding of the different classes of fire injury in their relation to the death of the tree through subsequent insect attack. The value of these data lies primarily in the prediction of insect outbreaks and the institution of salvage cuttings following fires. It has been found that the peak of insect losses occurs the year after the fire and that injury to the root collar is a far more important factor in determining the death of the tree than an injury to the foliage.

Biology and Control of the Spruce Budworm

During the past season our efforts have been directed toward the development of a spray which would be satisfactory for the protection of forested areas of high aesthetic or commercial values from the ravages of this defoliator. This work was conducted in the Douglas fir stands of the Cody Canyon where twenty-one different spray formulae were used on carefully selected plots. These sprays were applied with high power spraying equipment, and approximately 600 gallons of spray used for each plot. Each experiment was controlled through an untreated plot adjacent. Several sprays were used at different periods of the season in order to determine the most advantageous time for the institution of such control. Though the 1930 defoliation was very severe, a marked decline occurred in the 1931 feeding, due partly perhaps to the wide-scale spraying operation conducted during the previous season. This decline in the outbreak made the determination of the effectiveness of the sprays used very difficult, as in many cases the untreated plots were in as good condition as those treated. More intensive work on a much smaller scale will be conducted during the 1932 season.

Temperatures in Relation to Phenology

Temperature exercises in different ways a marked influence upon insect development. There are both high and low temperatures which are fatal to insect life. There are also zones of high and low temperatures where insect life is inactive, as well as a range of temperatures which are favorable to insect development. As can be seen, temperatures play an important role in determining the seasonal history of insects, the number of generations, flights, etc. Considerable work has been done in correlating phenological events of plants and trees with different seasonal dates, as well as the interrelation of plant and insect development. Realizing that temperature is the governing factor of both plant and insect development, an attempt will be made to determine the degree, duration, and occurrence of temperatures both favorable and unfavorable to plant and insect development,

with the idea of being able to foresee such seasonal history events of insects which govern the institution and cessation of control. Some work was conducted on this problem during the spring of 1931. However, it will be instituted early in 1932, and it is estimated that at least five years' data will be required before a correlation can be established.

OFFICE OF BLISTER RUST CONTROL

Research by the Office of Blister Rust Control was continued during 1931 on about the same scale as in 1930. The work is carried on as eight separate projects aimed to answer the most urgent problems in Ribes eradication and control and in rate of spread of blister rust.

Based on 247 permanent and 1579 temporary plots examined during the year it has been found that Ribes eradication work as now carried on will remove from 95 to 100% of the live Ribes stems from the area covered. The rate of spread from plants overlooked in eradication and from seed in the ground varies from 15 to 400% during the first year and an equal amount during the second year.

Eleven centers of infection originating in 1923 have been located in the Inland Empire. Study of these original centers shows that the number of cankers resulting from the initial infection was small but that the reverse is true as a result of secondary infections. Two waves of reinfection, one starting in 1926 and one starting in 1929, have resulted from the original infections. The following table shows the rate of increase in number of cankers:

Name of Area	Number of Cankers in First Cycle	Ratio of Number Cankers in First Cycle to Number Cankers in Second Cycle
Newman Lake, Wash.	43	1 to 40
Fishhook Cr., Avery, Ida.	50 Est.	1 to 3000°
Long Meadow Cr. Elk River	83 Est.	1 to 2742
East Fork Potlatch Cr. Bovill, Idaho	1	1 to 2°
Ruby Creek, Bovill, Ida.	12	1 to 705°
Deep Creek, Elk River, Ida.	5	1 to 197°
Deep Creek-Elk Creek Elk River, Idaho	3	1 to 416°
Deer Creek, Headquarters, Ida.	1	1 to 309°
Snake " " "	1	1 to 140°
Rhodes Creek, Pierce, Ida.	1	1 to 327°
St. Maries River, Clarkia, Ida.	50 Est.	1 to 420°

°- Extent of second cycle incompletely determined.

As a result of scouting in 1931 and previous years there have been located 61 separate infection centers; 11 of these are considered as primary

and 50 are assumed to have originated by spread from the eleven original centers. Because of the extent and ruggedness of the area concerned it seems certain that there are numerous other pine infection centers which have not thus far been discovered. Distribution of centers by Forest units follows:

Clearwater National Forest	2
Clearwater Timber Protective Association	12
Potlatch " " "	13
Coeur d'Alene " " "	5
St. Joe National Forest	25
Coeur d'Alene National Forest	2
Private land adjacent to Coeur d'Alene Forest	1
Private land, Newman Lake, Spokane County, Wash.	1
Total	61

The study of best methods to use for permanent stream type eradication was broadened to include power methods. Experiments were conducted at Savenac Nursery and on the Coeur d'Alene National Forest with road building bulldozers which indicate that this type of equipment can be adapted to the work and that its use will effect a reduction in costs on many areas.

The development of toxic chemicals effective in Ribes eradication, and the best method for their use, continues to give promising results. Recent tests indicate that Ribes inerme and Ribes lacustre, which have not been successfully eradicated by spraying or crown treatment, may be susceptible to the action of toxic chemicals when they are applied to the root system.

The work with toxic chemicals and on Ribes ecology is being carried on in close co-operation with the University of Idaho.

WEATHER BUREAU

During 1931 the Spokane Office of the Weather Bureau continued its service of daily weather forecasts, furnished to all forest protective agencies in this region throughout the season of fire danger. Although the accuracy of their forecasts is now so well appreciated that considerable organization changes are made according to the danger predicted, it is generally conceded that the predictions for 1931 were even more dependable than in the past.

The Spokane Office also has continued the practice started in 1930 of summarizing the records from all stations at the close of the year and making this summary available to all agencies to assist them in rating the character of the season, hence their efficiency of protection. A special report for this purpose was prepared in late September comparing 1931 with the previous critical seasons of 1929, 1926, and 1919. This report, with additional data on duff inflammability supplied by the Experiment Station,

was widely used both in this region and by the Washington Office of the Forest Service to corroborate the local opinion that 1931 was even more dangerous than the average critical season.

Meteorological instruments for several new stations were furnished and installed by the Weather Bureau at new locations on private, National Park, and Forest Service lands. Included were several recording anemometers for obtaining an automatic record of wind velocity in the Forests. These installations fill a well recognized need for more data on this factor of fire danger.

The investigation of types of weather which cause thunderstorms also was continued and a considerable number of type maps prepared which will be of practical value in improving future forecasts of thunderstorms. This research work is recognized as of special importance in this region because of the high percentage of forest fires caused by lightning. The progress already made in improving the forecasts of lightning also demonstrates the practical value of such research.

REPORT OF UNIVERSITY OF IDAHO

During the past year the University of Idaho Forest School carried forward a number of projects in artificial reforestation, management, protection, forest products, and forest economics, most of which were reviewed in the 1930 report. A number of these projects are now complete as far as the field work is concerned and are awaiting final compilation and preparation of the report. Other projects, as with all agencies, are continuing projects upon which additional data must be gathered before the investigation will be closed. Most of the work on artificial reforestation and mensuration projects and a great deal of the work in pathology (blister rust) and wood decay studies comes under one or the other of these heads.

Undoubtedly, the most interesting development at the University of Idaho during the past year has been the completion of an excellent laboratory, chiefly designed for research in wood chemistry and studies in the chemical and mechanical utilization of wood. Among a number of investigations underway at this laboratory, preliminary results are available on the fireproofing of fiber boards, the properties and derivatives of lignin, and the properties of oleoresin from the lowland white and alpine fir. It has been found that the oleoresin of alpine fir has properties as a mounting medium and lens cement equal to those of the Canada balsam now widely employed.

Interesting progress has also been made in a number of projects in the field of forest pathology. In the studies dealing with blister rust control definite progress has been made in the study of parasites attacking the rust and in culturing two fungi common on the rust in British Columbia and in Germany. Inoculation of the pycnial stage of the rust with Tuberculina maxima from laboratory cultures was successful and several field inoculations have been made on infected trees in the Elk River region.

Studies of laboratory media most suitable to the maximum production of the spores of this parasite are in progress. An intensive study of the pycnial stage of the rust is now underway with the object of determining the part this stage plays in the life history of the fungus. A method has been developed whereby pine seedlings used in experimental work may be infected with blister rust without the dangerous use of spores.

In wood decay studies laboratory tests have been completed on a new method of protecting window sash joints against decay and the best chemicals are being tested in sash placed in a recently constructed wood-rotting cellar. Dr. Hubert's textbook on forest pathology has been completed and published. This work covers tree diseases as well as diseases of wood products and emphasizes the diagnosis of disease and control methods.

A report on the Benewah County survey is now in first draft. It was found that in this county the degree of stocking in reproduction averaging 31 years of age varied from 19 to 82 per cent, the average for all townships covered being 53 per cent.

UNIVERSITY OF MONTANA

The research program carried by the Forest School at the University of Montana was sharply reduced during the past year on account of decreased funds. Ten of the eighteen projects were discontinued temporarily and four were dropped. The major project is the climatic study of the Northern Great Plains under way by Dean Spaulding. This is a complete and comprehensive study of the records maintained at some 26 Weather Bureau stations and when completed will be of great value to any forest or range research in that region. The report will be ready for publication early in the coming summer.